SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1909.

GENERAL PHYSICS.

1659. *Indication of Minute Movements.* (Brit. Pat. 4,547 of 1909. Engineer, 108. p. 154, Aug. 6, 1909. Abstract.)—In this patent of J. T. Irwin's the object whose movement is to be detected is fastened to two wires, the other ends of which are fastened to a flat spring which keeps the wires in tension. Two other wires are attached to the first pair so as to pull them out sideways at about their middle points. Any motion of the body in the line of the first pair of wires alters the sag of these wires, and this alteration is shown by means of a spot of light reflected from a mirror carried by the wires. A. W.

1660. *Model for Wave-motions.* **K. Hayakawa.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 6. pp. 96–101, June, 1909.)—Most types of wave apparatus are purely kinematical; they only show the appearance of propagation of waves, but do not touch its true nature. Others, such as Rayleigh's and Weinhold's, are dynamical, but only illustrate one type of wave-motion. The apparatus here described can be used to illustrate any type of waves, and the phenomena of reflection, stationary waves, resonance and beats can also be shown; moreover, the polarisation of light can be imitated. The apparatus consists of a number of double aperiodic vibrators. A horizontal vibrator, consisting of a straight rod carrying a wooden ball at one end and a counterpoise at the other, is attached by means of a universal joint to the top of a vertical vibrator which is supported by two horizontal points and carries a counterpoise at its lower end. Double vibrators of exactly similar construction are arranged side by side, and the horizontal and vertical rods are connected respectively by pairs of helical springs. Thus we get a series of balls which are elastically connected and movable in all directions. These balls represent particles in the elastic medium. By adjusting the springs the velocity of propagation of the vibrations in three planes may be made equal, so that if any arbitrary vibrations are given to the ball of either end the resultant motion of any ball will be the same as that of the source with a regular difference of phase. By suitable modifications stationary waves, &c., can be shown. The paper is illustrated with several photographs and diagrams. A. W.

1661. *New Hardness Testing Machine.* **T. Y. Olsen.** (Mech. Eng. 24. p. 251, Aug. 27, 1909.)—This machine is designed to carry out the Brinell test, and consists of two levers mounted on a frame. The load is applied by hanging weights at the end of one lever, causing the steel ball fixed to the end of the other lever to penetrate the specimen fixed between the steel ball and the frame of the machine. Depth of penetration is measured to $\frac{1}{10000}$ in. by an instrument arranged above the specimen on the main lever. A test can be carried out in less than a minute, and the machine can be adapted to testing materials of very varying hardnesses, the test load being increased with increasing hardness. F. C. A. H. L.

1662. *Automatic Weighing-machine.* **L. Masson.** (Bull. Soc. d'Encouragement, 111. pp. 1065–1079, June, 1909.)—A report presented by the writer on behalf of the *Comité des Arts mécaniques* on the system of automatic weighing-machines made by the *Manufacture d'horlogerie de Béthune.* This kind of machine has been approved in France by the Office of Weights and Measures for purposes of testing and standardising weights. It consists of an ordinary steelyard with constant weight and variable lever, with this difference, that its cursor, instead of being moved by the hand of the operator, is moved automatically up to the point of the beam where it is in equilibrium with the weight to be measured, by means of clockwork whose motion is stopped as soon as the equilibrium point is reached. The clockwork controls the needle or needles of one or more indicators, and also works a perforating machine for weight tickets. A lengthy description, with numerous diagrams, is given of the clockwork mechanism, for which the original paper should be referred to. A. W.

1663. *Pressure Perpendicular to Shear Planes and Lengthening of Wires when Twisted.* **J. H. Poynting.** (Roy. Soc., Proc. Ser. A. 82. pp. 546–559, July 31, 1909.)—It is admitted that the analysis mentioned in Abstract No. 1377 (1905) is at fault in that the diagonals of the rhombus into which a square is distorted by a pure shear are not the lines of greatest contraction and elongation, and are not at right angles under the stress when quantities of the second order are taken into account, *i.e.*, of the order of ϵ^2, where ϵ is the angle of shear. A revised analysis is given, which leaves the question open as to the existence of a longitudinal pressure. Hence it is found that the lengthening of a loaded wire of length l and radius a when twisted through an angle θ is $sa^2\theta^2/2l$, where s is $(n/2 + p)/\gamma + (2/\gamma - 1/n)q$, and γ is Young's modulus, n the rigidity; p and q are artificial quantities introduced in the analysis. The results of experiments to test this upon steel, copper, and brass wires give generally confirmatory results. When the wire is loaded sufficiently to be straightened, it is lengthened by twisting by an amount proportional to the square of the twist and with a given number of turns inversely as the length. The lengthening was never so much as 0·1 mm., therefore great accuracy was not obtained. s for steel is nearly 1, and for brass and copper about 1·5. The lengthening for brass and copper wires appeared to be different for clockwise and counter-clockwise twists. A hard steel wire shortened upon twisting, whilst only lightly loaded in tension. This was, however, probably due to coiling. The values of p and q cannot be found without simultaneous measurements of the decrease of diam. of the wire. It is shown that the effect of the correction due to the lengthening in the determination of rigidity by torsional oscillations is generally negligible.
F. R.

1664. *Tubes under External Fluid Pressure.* **M. Westphal.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1188–1191, July 24, 1909.)—The author has previously (Ibid. pp. 888 and 1165, 1909) calculated the strength and deflection of tubes under external pressure when the initial departure from the circular form is great compared with the elastic deformation. A solution is now given for a deflection which is large in comparison with the initial ellipticity. The total difference produced in two radii at right angles is $\epsilon r\beta/(1-\epsilon)$, and the max. bending moment is $M_0/(1-\epsilon)$, where the initial radii are r and $r(1+\beta)$; $\epsilon=(\pi/4-1/2)pr^3/EI$, p is the external pressure, and—

$$M_0=-pr^2/2+p(I_x+I_y)/2\pi(2+\beta)r.$$

F. R.

1665. *Steel under Combined Stress.* **C. A. Smith.** (Engineering, 88. pp. 238–243, Aug. 20, 1909.)—In discussing the available data, the author considers that the only reliable results are those of Guest and of Turner [see Abstract No. 364 (1909)] upon tubes under simultaneous tension and torsion, and those of Scoble [see Abstract No. 6 (1907)] upon solid bars under combined bending and torsion. These deviate from Guest's law by 6 or 7 per cent. Results of the author's experiments are given. Combined tension and torsion tests upon solid bars of a 0·2 per cent. carbon steel gave a max. shear stress, when elastic failure occurred, at a value varying 2½ per cent. from the mean. In tension-torsion and compression-torsion tests of solid bars of a 0·09 per cent. carbon steel the extreme variation was 1·87 per cent. from the mean. Similar tests on a 0·30 per cent. carbon steel gave variations of 4·02 per cent. from the mean; and combined tests on hollow specimens of a 0·21 per cent. carbon steel gave variations of only 0·21 per cent. from the mean. It is concluded that Guest's law is sufficiently accurate, in the case of mild steel, for all practical purposes, and is probably absolutely true. The results do not support the "friction" theory. The effect of unsymmetrical loading was provided for [see Abstract No. 359 (1909)]. It is pointed out that the max. shear stress and strain occur simultaneously, so that in this sense Guest's law (failure occurs under max. shear stress) is at once compatible with Rankine's suggestion (max. stress) and St. Venant's (max. strain). The ratio of working tensile stress to shear stress in mild steel should be 2 : 1 as deduced from the author's data for elastic failure. F. R.

1666. *Ageing of Mild Steel: Influence of Nitrogen.* **C. E. Stromeyer.** (Iron and Steel Inst., Journ. 79. pp. 404–420; Correspondence, pp. 421–425, 1909. Metallurgie, 6. pp. 363–370, June 8, 1909.)—Torsion, fatigue, alternate bending, static bending, and tensile tests, and chemical analyses have been carried out upon the steels referred to in Abstract No. 503 (1908). The torsion and fatigue tests throw no light upon the question of ageing, and so are omitted. The view is upheld that pieces which have been injured by chisel nicks on their edges, and then bent, deteriorate in time, and the deterioration can be accelerated by heating to 100° C. This brittleness, it is now found, is due to the presence of phosphorus or nitrogen or both. When placed in the order of the sums $N/0{\cdot}02+P/0{\cdot}096+As/0{\cdot}562$, *i.e.*, the ratios of the percentages of the respective elements to the square of their molecular weights divided by 100, it is found that when the sum is less than 0·80 the steel is good, with a few exceptions, for which special explanations are offered. Those with the highest values of this sum broke short in hammer bending tests, after having had a preliminary bending whilst at blue heat. The tensile strength in tons per sq. in., of the steels tested is given by $17{\cdot}20 + 35C + 10Si + 2{\cdot}5\,(Mn - 1{\cdot}72S) + 30P + 300N$. In the *discussion*, **E. H. Saniter** holds that the author's interpretation gives an unjust degree of importance to the effect of nitrogen. The author's percentages of nitrogen are in no cases abnormally high. F. R.

1667. *Strength of Columns.* **J. E. Howard.** (Eng. News, 62. pp. 232–233, Aug. 26, 1909. Paper read before the Amer. Soc. for Testing Materials, 1909.)—Results of experiments made at Watertown Arsenal are given. The curves relating mean compressive stress at failure to ratio of length to radius of gyration are approximately coincident for flat, spherical, pin, and fixed ends for 5-in. tubes, and up to $l/r = 125$ to 150 for flat- or pin-ended 6-in. rolled I-beams and 10 × 8 in. riveted I-section beams. For $l/r = 50$ to 125 the mean ultimate stress coincided roughly with the elastic limit of the metal, viz., 30,000 lbs. per sq. in. A flat-ended column, $l/r = 150$, cut in halves and butted without joint at the centre, carried a mean ultimate stress of 29,280 lbs. per sq. in. The curve for the built columns does not, like the other curves, rise sharply at values of l/r less than 50. Thus the plates and angles composing these columns appear to act independently of each other. F. R.

1668. *Lateral Strength of Beams.* **H. D. Hess.** (Eng. Club Phil., Proc. 26. pp. 106–111; Discussion, pp. 111–112, April, 1909.)—Regarding the compression flange of an I-beam as a column, with ordinary methods of loading, such as a single or a uniformly distributed load, it is seen that by differentiating the column formula the length of compression flange which gives the greatest probable added stress by its tendency to buckle can be found. This is $1/\sqrt{2}$ of the span for a uniform load, and 2/3 of the span for a simple beam with central load, or a cantilever with a single end load. Hence the additional stress can be determined. The case is also considered when the tension flange adds to the lateral stiffness. In the *discussion*, the **Author** points out that the truth probably lies between the value given by considering the compression flange only as contributing to the lateral stiffness and that found by considering both flanges. **J. Christie** refers to experiments which he made 25 years ago, but states that the results as regards lateral strength were unsatisfactory. F. R.

1669. *Bond in Reinforced Concrete.* **H. C. Berry.** (Eng. Record, 60. pp. 93–95, July 24, 1909. Paper read before the Amer. Soc. for Testing Materials.)—A modification of a method proposed by Withey was used. The steel rod was embedded in the lower side of the concrete beam which was divided at the centre to allow observation of the rod. The compression thrust was transmitted through a pin placed near the top between the two portions of the beam. The mean bond per sq. in. of square and round bars was 237 lbs. per sq. in. Comparison tests on rods pulled out of cylinders directly gave 618 lbs. per sq. in., and on rods pushed out of cylinders 497 lbs. per sq. in. The beam test value is preferred for guidance in beam design, as the conditions of the test approximate more closely to practice than the ordinary pull-out or push-out tests. 1 : 2 : 4 concrete was used, and results are given for different proportions of water used, and compression tests on cubes are also added. F. R.

1670. *Portland Cement: The le Chatelier Test.* **A. C. Davis.** (Inst. Civ. Engin., Proc. 175. pp. 280–289, 1908–1909.)—The author's results indicate that cement made by any process does not give a greater expansion in the le Chatelier test as its age increases, or upon aeration, but, on the contrary, a reduced expansion. It is considered that duplicate le Chatelier tests agree well with one another as tests of cement go, and particularly so in the case of rotary cements. The more coarsely ground portions of cements give much the greatest expansion. Cements made in rotary kilns, whether freshly ground or aerated, more readily pass the le Chatelier test than others. F. R.

1671. *Energy of Springs.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 82. pp. 387–389, July 26, 1909.)—A discussion of the utilisation of the energy stored in springs for the production of mechanical work. The object of the note is to show in what way the work stored in stretched indiarubber may be most fully utilised, and so utilised as to supply power at a constant rate. The most convenient form in which the indiarubber can be used is that of a long strip or band wound on a drum or reel under tension, and in order to convert the potential energy into mechanical work it is shown that the conversion cannot be effected continuously, but must proceed in cycles, and that the condition of efficiency is that each portion of the elastic band whose contraction is being utilised must be unwound from the drum without change of tension, and that the part so unwound must then be isolated by clamping or otherwise, and allowed to contract without contact with other bodies except at the clamped ends. The author has constructed a small model on which this process is carried out automatically. It is also shown that where a belt is used for transmitting power its efficiency is greater the greater Young's modulus for the material is. A. W.

1672. *Wave-motion of a Revolving Shaft and Angular Momentum of Circularly Polarised Light.* **J. H. Poynting.** (Roy. Soc., Proc. Ser. A. 82. pp. 560–567, July 31, 1909.)—The movement of orientation of the section at x of a uniformly rotating shaft is given by $\theta = 2\pi(\mathrm{N}\lambda t - x)/\lambda$. The solution $\theta = \Theta\, 2\pi(\mathrm{U}_n t - x)/l$ of the equation of motion for twist waves in a circular shaft can be made to coincide with this if $\Theta/l = 1/\lambda$ and $\mathrm{N}\lambda = \mathrm{U}_n$. Hence for a given value of N there is only one value of λ or of ϵ for which the motion may be regarded as part of a natural wave system transmitted by the elastic forces of the material with velocity $\sqrt{(n/\rho)}$, *i.e.*, there is only one "natural" rate of ransmission of energy. Here $\tan\epsilon = 2\pi a \mathrm{N}\sqrt{(\rho/n)}$, ϵ is the angle between the spiral formed by a distorted generator of the shaft and the axis, N is the number of revs. per sec., λ the pitch of the spiral; U_n is the velocity of wave-motion with wave-length l. When, as usually occurs, the shaft transmits power at other than the natural rate, the waves must be regarded as forced, and it is necessary to apply external forces in addition to the elastic forces in order to give the new velocity. An expression is obtained for the couple required, and the theory is also developed by Rankine's tube method of obtaining wave velocities. Assuming that the condition travels with velocity U unchanged in form the transmission of energy in the three cases $\mathrm{U} \gtreqqless \mathrm{U}_n$ are considered. A uniformly revolving shaft serves as a mechanical model of a beam of circularly polarised light. The expression $\theta = 2\pi\,(\mathrm{U}t - x)/\lambda$ gives the orientation of the disturbance which constitutes polarised light, whatever its nature. The energy and torque are analogous, and it is suggested that angular momentum $\mathrm{E}\lambda/2\pi$, *i.e.*, $\mathrm{P}\lambda/2\pi$ per sec. may therefore be given up per unit area of an absorbing surface upon which such light with energy E per unit volume falls normally: P is the pressure. An experimental method of multiplying this effect, which is only of the order 10^{-5}P is suggested. A series of quarter-wave plates are alternately fixed and suspended from a fibre. The light from a Nicol prism falls through them, so that the portions of torque on each suspended plate are added. It is not expected, however, that even this method would give sufficient multiplication to make the effect detectable, if it has the value suggested by the mechanical model. F. R.

1673. *Vibration and Whirling Speeds.* **A. Morley.** (Engineering, 88. pp. 135–137, July 30, and pp. 205–206, Aug. 13, 1909.)—The calculation of various cases of whirling speeds of shafts for different end conditions, and for concentrated or large loads, or variable diam., are given. Allowing for the size of loads the formula for time of vibration is—

$$2\pi\sqrt{\left\{[\Sigma(Wy^2) - \Sigma(Wk^2\theta^2)]/g\Sigma(Wy)\right\}}$$

A distributed load may be dealt with by terms $\int wy^2dx$, &c., generally to be found graphically, in place of $\Sigma(Wy^2)$, &c. Alternatively the whirling speed of the shaft considered as weightless, but loaded, may be combined with that of the shaft carrying its own weight only by Dunkerley's empirical rule $T^2 = T_1^2 + T_2^2 +$ &c., which holds approximately for both whirling and vibration. The general equation of frequency of vibration is—

$$[W(p^2 + \omega_1^2)/g - 12EI/l^3][Wk^2(p^2 - \omega_1^2)/g - 4EI/l] = 36(EI/l^2)^2.$$

When $\omega_1 = 0$ this becomes the frequency equation of simple transverse vibration, and when $p = 0$, ω_1 is the whirling speed; y is amplitude of vibration, $p = 2\pi n = 2\pi/T$, ω_1 is angular velocity. F. R.

1674. *Vibration of Ships.* **J. B. Henderson.** (Inst. Naval Architects, Trans. 51. pp. 29–41; Discussion, pp. 41–46, 1909. Engineer, 107. pp. 349–350, April 2, 1909. Engineering, 87. pp. 452–454, April 2, 1909.)—The periods of vibration of a dynamic model, consisting of a 4-ft. bar, ¾ in. deep, and of varying breadths to give the same moment of inertia curve as the ship, and similar load curve, were found to correspond in the case of H.M.S. *Pathfinder* to a frequency of vertical vibration of the ship of 127 per min. The actual frequency of the ship was 106 per min. Hence the equivalent modulus of elasticity for the ship is $106^2/127^2 = 0{\cdot}7$ times the modulus for the bar. In the case of the *Lusitania* the dynamic model indicated a frequency of 74·6 per min. for the ship; the actual frequency is 65, hence the modulus for the ship is 0·67 times the modulus for the bar. The sources of error of the method are discussed. From some pallograph records of the *Lusitania* a vibration of about one-seventh the frequency of the propeller-blade impulse is traced to interference of the impulses of the four screws. The *Mauretania's* records show horizontal and vertical vibrations of the same period as the blade impulses, and also intermittently a vibration of one-seventh the frequency of the propeller impulse, and as the highest frequency of beats in the fundamental is only 4·5, this must have been directly excited by the propeller-blade impulse. F. R.

1675. *Decay of Surface Waves produced by a Superposed Layer of Viscous Fluid.* **W. J. Harrison.** (Roy. Soc., Proc. Ser. A. 82. pp. 477–483, July 26, 1909.)—The author first discusses theoretically the motion of two fluids, both of depth large compared with the wave-length of the motion, in the two cases (i) both very viscous; (ii) the lower one slightly viscous, the upper very viscous. Taking the case of a thin layer of glycerine superposed on deep mercury, it is shown that all waves above a certain minimum wave-length are propagated, while below this limiting value the waves are dead-beat. The damping effect of a layer of glycerine 1 mm. depth is very noticeable. The rate of decay of any arbitrary disturbance will depend, in general, on the rates of decay of those of the modes, into which it can be analysed, which are propagated. The other modes disappear instantaneously. As a consequence of this the curvature of the upper glycerine surface is always the same as that of the mercury surface—a fact which may be of importance in the application to an optical instrument such as Wood's [see Abstract No. 804 (1909)]. Wood used a depth of 4 mm. of glycerine, which would give a much greater rate of decay than 1 mm. In the present investigation the damping effect of the air has been neglected, but in the case of mercury its effect is practically negligible. From a table given it is seen that the modulus of decay, when the vibrations are influenced by the glycerine layer, increases much more slowly with the wave-length than in the case of a clean mercury surface. This fact may go a little way towards an explanation of the damping of waves on water by oil. But a complete explanation is to be looked for in a totally different direction. Houstoun notes [Abstract No. 218 (1909)] an experimental result which is apparently contradictory to usual experience. The modulus of decay for waves of length 5 cm., when the surface of the mercury is covered by 4 mm. of glycerine, is 4·9 sec. All modes become propagated for wave-lengths greater than some value between 5 and 10 cm. For a depth of 1 mm. of glycerine this limit lies between 10 and 20 cm., and thus as the depth is increased this critical value of the wave-length approaches that for waves at the surface of deep glycerine, which lies between 2 and 3 cm. A. W.

1676. *An Experimental Laboratory of Aerodynamics.* **S. Drzewiecki.** (Aeronautics, 2. pp. 99–101, Sept., 1909.)—The want of a laboratory such as is here proposed is pointed out. The power plant and transmission do not come within the scope of the institution. In the equipment, a wind tunnel forming a closed circuit in order to save power is necessary; this should be elliptical in section (major axis horizontal) and 10 to 18 ft. in diam., the return limb of the circuit forming a parabola in a vertical plane to permit of the testing of gliders in ascending currents of various angles. Wind velocities to 80 ft. per sec. should be provided by two fans driven by motors mechanically coupled to ensure uniform speed. A schedule of preliminary experiments is suggested. C. A. B.

1677. *Resistance of Plates and Models in a Current of Water.* **T. E. Stanton.** (Inst. Naval Architects, Trans. 51. pp. 164–169; Discussion and Correspondence, pp. 169–175, 1909. Engineering, 87. pp. 524–526, April 16, 1909. Engineer, 107. pp. 405–406, April 16, 1909.)—Results were obtained on plates and models in a channel 12 in. wide by 7 in. deep, with water flowing at a velocity of 2·4 ft. per sec. The intensity of normal pressure on plates of constant area (2 sq. in.) inclined to the current presents the same characteristics as those of similar plates in air currents. Up to 15° $P = 1{\cdot}8V^2 \sin \alpha$ for the square plate, $P = 2{\cdot}7V^2 \sin \alpha$ for 2 in. × 1 in. plate with short axis in horizontal plane, and $P \propto \sin 1{\cdot}4\,\alpha$ for 1 in. × 2 in. plate with long axis horizontal. The "hump" in the curve occurs at 35° for the square plate, 45° for the long plate, and 25° for the short plate. Plano-convex plates gave higher pressures at small inclinations, in the ratio of 1·2 at 4°, but equal at 16°.

For a plate 1 sq. in. in area the pressure for normal impingement was $1{\cdot}20V^2$. With a tapered model in front of a plate, so that the streams impinging on the plate are divergent, the normal pressure is much reduced, and more so the greater the angle of the model, but never to zero. The following are the relative resistances of three models having one end in the form of a hemisphere, all of the same radius, and the other end a cone:—

Angle of Cone.	40°.		20°.		10°.	
	Cone facing Stream.	Hemisphere facing Stream.	Cone facing Stream.	Hemisphere facing Stream.	Cone facing Stream.	Hemisphere facing Stream.
Resistance	K	0·99K	0·76K	0·59K	0·69K	0·51K
Resistance per unit volume ...	R	0·99R	0·52R	0·40R	0·28 R	0·21R

The shielding effect of a similar parallel plate ahead of a plate set at a small inclination to the current is very considerable, when even 9 lengths ahead, and at 6° inclination. There is also marked interference when the leading plate is moved even a considerable distance aside. The bearing of these results on propeller action is discussed. F. R.

1678. *Ratings of a Pilot Tube.* **E. C. Murphy.** (Eng. News, 62. pp. 174–175, Aug. 12, 1909.)—The results of some experiments on the rating of a Pitot tube. If the water is at rest in a trough then the rating of the tube depends upon the distance of the point of the tube from the surface of the water. Thus there is a gradual decrease in the column difference, for any velocity of the tube, as the point of the tube is moved upwards from the bottom of the trough. These results may differ considerably from those obtained when the tube is rated in moving water. It is therefore concluded that Pitot tubes should be rated in moving water and the range of depth of water used in the rating should be about the same as that to be measured.

W. C. S. P.

1679. *Dependence of Diffusion-coefficients of Gases on Concentration.* **A. Lonius.** (Ann. d. Physik, 29. 4. pp. 664–678, July 6, 1909. Physikal. Inst., Halle, April 28, 1909.)—The diffusion-coefficient of a gas is not a constant, but shows variations up to 8 per cent., according to its concentration in the gas which acts as "solvent." The variations are sometimes in one direction and sometimes in the other, according to the nature of the gaseous mixture selected. T. M. L.

1680. *Viscosity of Gases.* **G. Zemplén.** (Ann. d. Physik, 29. 5. pp. 869–908, Aug. 10, 1909.)—As the vibration methods did not guarantee great accuracy, the deflection method was chosen, and, two concentric spheres being taken, the inner one was suspended by a wire and the outer one rotated round it on a vertical axis at a known speed. The deflection of the inner sphere by the gaseous friction was measured and the viscosity coefficient is calculated by means of a formula derived from the fundamental hydrodynamic equations. The coefficient was found to be independent of the velocity of rotation within the limiting times of revolution 288 sec. and 22 sec., and the mean value found was $\eta_{18} = 1{\cdot}9114 \times 10^{-4}$. When the time of revolution became 2·88 sec. the formula deduced for infinitely small velocities was no longer applicable. Further, when the air is saturated with water-vapour, the coefficient is increased 0·8 per cent. over that for dry air.

G. E. A.

1681. *Barometric Pressure, Relative Humidity, and Vapour Tension at the Summit of Monte Rosa, and at Alagna.* **C. Alessandri** and **F. Eredia.** (Accad. Lincei, Atti, 18. pp. 47–52, July 18, 1909.)—Average hourly values for the barometric pressure, relative humidity, and vapour tension, during the complete 24 hours, are given for periods of 10 days in July, Aug., and Sept., 1907 and 1908. At Monte Rosa the average barometric pressure is about 439, and at Alagna 663 mm., and the variation at both places is but slight, the range being only 1·07 and 0·91 mm. respectively. The general course of the variation in relative humidity is very similar at both places, with a maximum at the last hour of the 24, and a minimum at midday. Between 11 h. and 14 h. the values are comparatively close together, usually between 50 and 60, but the difference between them increases at night, the relative humidity at Monte Rosa attaining a maximum of 78, while at Alagna as high as 91·8 was reached at 24 h. The vapour tension at Monte Rosa is much less than at Alagna, and shows very little change during the 24 hours, ranging only from 1·42 to 1·49; at Alagna it varies from 8·18 to 10·52. W. H. Si.

1682. *Measurement of High-frequency Earth Tremors.* **L. Grunmach.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 39. pp. 969–980, 1909.)—The author and F. Weidert have investigated artificially produced vibrations of rock strata with seismographic apparatus of a specially designed type. It comprised a triple pendulum set for measuring the max. value of the acceleration in three mutually perpendicular directions, and a horizontal pendulum for measuring the amplitude of the displacement. The principle of the apparatus for registering the max. vertical acceleration was as follows. If a mass m lying on a horizontal surface is acted on by a force f vertically upwards, then contact will cease if the horizontal surface descend with acceleration a given by $a = g - f/m$. By varying f, this critical acceleration will assume any desired value. In the actual apparatus a heavy mass is mounted on a hinged lever, and a small sphere at the free end rests on a flat horizontal support. Adjustable springs attached to the heavy mass give the means of varying the contact pressure between the sphere and the plane surface. The breaking of contact was electrically recorded, and an alloy of 50 per cent. osmium and 50 per cent. iridium for the contact pieces gave the best results. For recording the displacements (0·004 to 0·00005 mm.) with the horizontal pendulum high multiplication was necessary. Levers were useless on account of the very short period of the vibrations (0·029 to 0·0025 sec.), and the usual optical methods were unsatisfactory. Microphotographic and electrical registration methods were devised. With the former the image of a suitable illuminated mark on the pendulum boom was transmitted by a projection microscope to a modified Edelmann registering apparatus about 1 ft. distant. 1,000-fold magnification could thus be obtained, and the magnification could be easily and quickly varied. For the electrical registration two coils attached to the pendulum boom moved in the cylindrical pole-gaps of two electromagnets. The induced currents actuated an

Edelmann string-galvanometer with a free period of 0·0015 sec. The cores of the coils being of brass gave the necessary damping to the system. The author derives the formulæ for calculating the displacements from the galvanometer readings. A. D. R.

1683. *Rigidity of the Earth.* **C. Lallemand.** (Comptes Rendus, 149. pp. 836–840, Aug. 2, 1909.)—If the earth were absolutely rigid there would be, as a result of lunar action, a semi-diurnal movement of the vertical in an ellipse. The author has calculated the axes A and B of this ellipse, and compares this ellipse with the actual path deduced from Hecker's observations with two horizontal pendulums at Potsdam. For the E.–W. direction the observed deviations from the mean positions are 0·71 of the theoretical values for an absolutely rigid earth. This differs but little from the fractions 0·65 and 0·67 otherwise obtained by Schweydar. For the N.-S. direction, however, the ratio is only 0·36, or barely the half. The author ascribes this difference to the apparatus, or to its mode of installation, or to a peculiar structure of the earth's crust near Potsdam, or probably to the tetrahedral deformation of the globe—the rigidity of the crust being different along and across the neighbouring European-Asiatic ridge. He draws attention to the discrepancy which exists between determinations of the earth's rigidity from tidal observations and those from the movement of the pole. Schweydar's hypothesis of a nucleus of rigidity $n = 20 \times 10^{11}$ and a crust of rigidity $n = 0·9 \times 10^{11}$ separated by a fluid stratum attempts to remove the difficulty, but the theory is objected to by Love. A. D. R.

1684. *Earth Tides and the Earth's Rigidity.* **C. Lallemand.** (Comptes Rendus, 149. pp. 888–892, Aug. 9, 1909.)—A theory is given which seems to remove the disagreement between the two chief methods of determining the earth's rigidity [see preceding Abstract]. The variation of lunar and solar potential at different points on the earth's surface is considered as giving rise to slight perturbative or deforming forces, which in conjunction with the earth's rotation produce oceanic and earth tides. The apparent or relative amplitude of the oceanic tides is derived as a function of the earth's elasticity and density. It is assumed that the earth at the moment when it commenced to solidify had its present ellipticity and law of variation of density. With this assumption, and employing Newcomb's relation between the ellipsoidal deformations and the Euler and Chandler-Kimura periods of polar movement, the amplitude of oceanic tides is found to be 0·70 of what it would have been for an absolutely rigid earth. This method of calculation gives 49 cm. and 19 cm. respectively for the equatorial spring and neap tides. On the Roche-Wiechert hypothesis as to variation of density in the earth's interior it leads to a mean rigidity for the earth of $6·3 \times 10^{11}$, a value which lies between those for copper and steel. [Ibid. p. 520, *Errata.*] A. D. R.

1685. *Is the Material Universe Infinite?* **S. Arrhenius.** (Ark. för Mat. Astron. och Fysik, Stockholm, 5. 1. pp. 1–14, 1909.)—The chief views on this question are summarised, and Charlier's hypothesis is discussed in detail. The author concludes that the stellar system is distributed through infinite space with approximately uniform density. The presence of dark bodies in space is considered sufficient to account for the comparatively small amount of stellar light which we receive, without recourse to the unsatisfactory theory that the ether can absorb an infinite amount of energy. It is shown that the nebulæ may absorb radiant energy and yet maintain a low temperature. Moreover, a homogeneous stellar distribution extending indefinitely in *all* directions need not give an infinite value to the potential function. The complexity of the evolution process is brought forward as a strong argument against the Charlier theory of the distribution of matter in space. A. D. R.

REFERENCES.

1686. *Pantograph for Magnetograph Records.* **K. Luyken.** (Zeitschr. Instrumentenk. 29. pp. 1–14, Jan., 1909.)—An illustrated description of a pantograph made by A. Schmidt, of Potsdam, for converting the scales of the curves obtained on the recording instruments to exact multiples of the magnetic or time elements respectively. Results of a test of one such instrument for the German Antarctic Expedition are appended. L. H. W.

1687. *New Automatic Mercury Pump.* **P. Klein.** (Comptes Rendus, 148. pp. 1181–1183, May 3, 1909.)—An illustrated description of a pump which automatically effects connection alternately with a water-jet exhauster and the atmosphere. L. H. W.

1688. *Equilibrium Figure of a Uniformly Rotating Fluid Body.* **N. Crudeli.** (N. Cimento, 16. pp. 271–297, Oct., 1908.)—Mathematical treatment of the problem of Tchebychef. L. H. W.

1689. *Flexural Vibrations of Thin Rods.* **G. Green.** (Roy. Soc. Edinburgh, Proc. 29. pp. 393–400, 1908–1909.)—Mathematical.

1690. *Principal Stresses and Planes in a Dam.* **F. H. Hummel.** (Inst. Civ. Engin., Proc. 176. pp. 294–297, 1908–1909.)—From Unwin's suggested method of calculating the principal stresses and shears in a masonry dam (Engineering, 79. pp. 513, 593, 1905) the author gives a diagram of the principal planes and stresses for a dam of triangular section. F. R.

1691. *Design in Case of Combined Stress.* **E. L. Hancock.** (Eng. News, 62. pp. 256–257, Sept. 2, 1909. Eng. Record, 60. pp. 399–400, Oct. 9, 1909.)—Covers the same ground as in paper referred to in Abstract No. 7 (1909), but is revised to include Turner's results, for which see Abstract No. 364 (1909). F. R.

1692. *Logarithmic Graphical Calculation of Springs.* **V. Fischer.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1075–1077, July 3, 1909.)—Ordinary formulæ for spiral springs as used by Kirsch are put into logarithmic form and plotted for ready application in spring problems. F. R.

1693. *Graphic Method for Stress and Deflection of Spring.* **A. Röver.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1272–1273, Aug. 7, 1909.)—A graphical method founded upon Tolle's calculation for a spiral spring whose axis is placed radially and which is stressed by centrifugal force. F. R.

1694. *Group-velocity and Propagation of Waves in a Dispersive Medium.* **G. Green.** (Roy. Soc. Edinburgh, Proc. 29. pp. 445–470, 1908–1909.)—Mathematical.

1695. *Internal Friction in Cases of Compound Stress.* **G. H. Gulliver.** (Roy. Soc. Edinburgh, Proc. 29. pp. 427–431, 1908–1909.)—The values of the coefficient of internal friction (μ) for steel deduced from Guest's and Hancock's results range from $-0{\cdot}242$ to $+0{\cdot}380$ and thus do not allow of assigning a definite value. F. R.

LIGHT.

1696. *Ponderomotive Force of a Luminous Field.* **N. P. Myškin.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. 4. pp. 161–190 (Physical Part), 1909.)—The author describes further experiments, which show that the phenomena previously described [see Abstract No. 2069 (1907)] are not due to the action of air-currents. The ponderomotive force of light is exhibited within the geometrical shadow thrown by a screen, and is also observed inside an opaque envelope, through which ordinary light is incapable of penetrating.
T. H. P.

1697. *Biaxial Crystalline Liquids.* **F. Wallerant.** (Comptes Rendus, 148. pp. 1291–1292, May 17, 1909.)—The biaxial character of liquid-crystals of azoxyanisol was clearly seen in the case of liquid-crystals prepared by warming the solid: when prepared by cooling the liquid the orientation was different and the second axis could only be detected at the extreme edge of the field.
T. M. L.

1698. *The Proposed International Unit of Candle-power.* **C. C. Paterson.** (Phil. Mag. 18. pp. 263–274, Aug., 1909.)—The writer gives a brief summary of the steps which have led to the suggested international unit of candle-power to be adopted by Great Britain, France, and the United States. The paper commences with a *résumé* of the nature of the units and standards at present officially adopted in these countries, and passes on to some remarks on the accuracy of comparison of standards which, he states, even under the most favourable conditions must be regarded as liable to an error of ±0·1 per cent. This degree of accuracy is undoubtedly obtainable in the comparison of properly seasoned electric glow-lamps which yield the same coloured light; but on the other hand, in comparing gas flames the accuracy is usually lowered. The writer then proceeds to tabulate the various results which have been obtained in the intercomparison of national standards by various observers during the years 1903–1907, which, on the whole, show very satisfactory agreement. Lastly he gives the official announcement regarding the new international unit which has been published simultaneously in the three countries interested. According to this announcement the proposed new unit is equal to:—

1 Pentane candle.	1·11 Hefner unit.
1 Bougie decimale.	0·104 Carcel unit.
1 American candle.	

Therefore 1 Hefner unit = 0·90 of the proposed unit.
L. G.

1699. *Europium, Gadolinium, Terbium, Neo-ytterbium, and Lutecium.* **G. Urbain.** (Chem. News, 100. pp. 73–75, Aug. 13, 1909.)—The conclusions drawn by the author from the results of a large number of experiments on the metals of the rare earths are as follows: The elements $S\delta$ of Crookes, $Z\zeta$ and $Z\varepsilon$ of de Boisbaudran are identical with Demarçay's europium, atomic weight 152·0; this element possesses an emission spectrum, an absorption spectrum, and a phosphorescence spectrum, which last appears only when the derivatives of europium are mixed in suitable diluents. The element victorium of Crookes is identical with gadolinium, Gd = 157·3, which also exhibits the three sorts of spectra. The elements Γ of Demarçay, $Z\beta$ and $Z\delta$ of de Boisbaudran, $G\beta$, ionium and incognitum of Crookes are identical with terbium, Tb = 159·2. The elements Δ of Demarçay, $Z\alpha$ and $Z\gamma$ of de Boisbaudran, $G\delta$ of Crookes, and X_3 of Exner and Haschek are identical with de Boisdaudran's dysprosium, Dy = 162·5. Marignac's ytterbium is a mixture of at least two elements, one of which, lutecium, is defined by an atomic weight of about 174, and by a line and a band spectrum. The residue, with a mean atomic weight of 172, is termed neo-ytterbium by the author and is apparently a mixture of two elements. T. H. P.

1700. *Number of α-Particles by Scintillation Method, and the Magnitude of Unit Quantity of Electricity.* **E. Regener.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 38. pp. 948–965, 1909.)—This is a detailed account of a method of ascertaining the number of α-particles given off by a polonium preparation. The chief points in the experiments are that the screen used is either very finely powdered zinc blende or diamond dust, so that it is almost certain that every α-particle produces a scintillation; a very large number of scintillations is counted; and the charge carried by the α-particles is measured in a good vacuum. The amount of charge received per sec. when divided by the number of α-particles gives the atomic charge as $9{\cdot}58 \times 10^{-10}$ E. S. unit, so that if we accept that each α-particle carries two elementary charges, then that charge will be $4{\cdot}79 \times 10^{-10}$ unit. A. E. G.

1701. *Electrical Measurement of Radio-active Rays.* **E. Lagrange.** (Phys. Zeitschr. 10. pp. 543–547, Aug. 15, 1909. From the French.)—The method employed depends upon using a graduated condenser with an alterable capacity in combination with another condenser in which the radio-active substance is placed. This non-graduated condenser consists of two brass sheets of 20 cm. diam. having slightly rounded edges. A Wulf electrometer is used as measuring instrument. One coat of each condenser and the case of the electrometer are earthed, the needle of the electrometer and the other coats of the condensers being connected and the whole raised to a definite potential by means of a battery of accumulators. In an experiment the voltage is kept constant by changing the capacity of the graduated condenser, and the amount of change necessary enables one to measure the current due to the radio-active substance, when due allowance has been made for the leak due to apparatus alone. A. E. G.

1702. *Separation of New Radio-active Disintegration Products.* **O. Hahn.** (Electrician, 63. pp. 909–910, Sept. 17, 1909. Abstract of paper read before the British Assoc. at Winnipeg.)—In collaboration with L. Meitner the author put forward as a working hypothesis that single radio-active products emit only one type of radiation, either homogeneous α-particles or homogeneous β-particles [see Abstract No. 1098 (1908)]. This working hypothesis has proved fertile in the case of the active deposits of Th, Ac, and Ra [Abstracts Nos. 1961, 1963 (1908), and 474, 649 (1909)]. In the quickly decaying active deposit of Ra we have apparently single β-rays from RaB and complex ones from RaC. Hence RaC must be complex, and consist of three products, one α- and two β-ray substances. The effect by the "recoil" method in the case of RaC is very weak. Supposing the α-rays to be emitted from the last product of RaC the result seems to show that RaC is really complex, comprising besides one product of 19 minutes' duration, another of 1 to 2 minutes', and yet a third with still shorter life. But there is still a better possibility of proving the correctness of the hypothesis. The authors have found that Ra itself emits β-rays of a quite distinct character. As it is known that Ra also emits α-particles, Ra must be complex and consist of two different products, say Ra and RaX. It seems that Ra itself emits easily absorbable β-rays only, and the hypothetical RaX emits the α-particles. Should Ra prove to be complex, other radio-active transformation products which emit complex rays ought to be looked upon as complex also. A. E. G.

1703. *Radio-activity of Rubidium Compounds.* **E. H. Büchner.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 154–157, Aug. 31, 1909.)—The photographic method is used. The various salts are in the anhydrous state. Plates exposed to K_2SO_4 for 81 days, and to Na_2SO_4 for 117 days show no blackening on developing, but with Rb_2SO_4 a black spot is clearly seen. In these instances the plates are enclosed in black paper, having a small circular hole so cut that the salts are separated from the plate by only 3 or 4 mm. of air. When this hole is covered with Al-foil 0·001 mm. thick, the salt being placed on the foil, a similar result is obtained after 97 days' exposure. It appears, therefore, that Rb exhibits a stronger action than K or Na. Some Rb_2SO_4 is next dissolved in water in the dark. Some drops are placed on a glass plate, and after evaporation to dryness the plate is heated for some time at 150° so as to obtain dry Rb_2SO_4. This is covered with Al-foil and a photographic plate placed on it at a distance of 0·5 mm. After 100 days the plate is developed just like another plate placed in the box but not exposed to the salt. A black spot is visible only on the plate exposed to Rb. This seems to show that rubidium emits a radiation which does not have its origin in an energy previously absorbed from outside sources. Further experiments are in progress. A. E. G.

1704. *Radio-activity of Ordinary Matter.* **M. Levin** and **R. Ruer.** (Phys. Zeitschr. 10. pp. 576–579, Sept. 1, 1909. Inst. f. physikal. Chemie, Göttingen, July 29, 1909.)—The photographic method is employed, exposures extending over a period of half a year. As the plates are covered in black paper only β- and γ-rays could affect them. The results are arranged according to the groups of Mendeléeff's table. *In Group I.*—Li, Na, Cu, Ag, Au, as well as their salts, are unable to impress the plate; on the other hand, all the salts of potassium used are found to be active, as are also the nitrate and chloride of Rb. Of the caesium salts only the nitrate is tried, and this is found to be inactive. *In Group II.*—Salts of Mg, Ca, Sr, Ba, Zn, Cd, and Hg have no action, while with two preparations containing beryllium the plates are affected. It is, however, certain that if beryllium is radio-active its activity is but extremely slight. *In Group III.*—Boron, Al, Yt, In, and Tl show no action on the plate. Scandium, ytterbium, and gallium are not examined, but two preparations of lanthanum are active; it is, however, by no means certain that this is not due to the presence of thorium. *In Group IV.*—Carbon (both amorphous and graphite), Si, Ti, Zr, and Sn produce an effect. Four cerium preparations are examined and found active, but thorium is afterwards proved to be present. Two specimens of lead are experimented with, and it is concluded that this metal is not radio-active. *In Group V.*—Phosphorus, vanadium, As, and Bi show no action. The preparation of antimony examined shows an activity probably due to traces of potassium. Niobium and tantalum may possess radio-active properties in a very weak degree. The rare earths, erbium and neodymium, possess a feeble activity, probably due to presence of thorium in the specimens examined, while a mixture of gadolinium, samarium, and praseodymium oxide has no action on the plate. *In Group VI.*—The elements sulphur, Se, Te give no action, neither do preparations containing Cr, Mo, and tungsten. *In Group VII.*—The halogens and manganese have no action, and the same is true for the elements contained in *Group VIII.* A. E. G.

1705. *Atmospheric Radio-activity on High Mountains.* **A. Gockel** and **T. Wulf.** (Phys. Zeitschr. 9. pp. 907–911, Dec. 15, 1908.)—Wires exposed on the Matterhorn at heights of 3,000–3,300 m. above sea-level show but little activity due to thorium, in contrast to the observations on the Brienzer Rothorn [Abstract No. 2050 (1907)]. Experiments with rain and snow give results contrary to those of Jaufmann (Meteorolog. Zeitschr. 24. p. 337, 1907). [See also Abstract No. 670 (1909).] L. H. W.

1706. *Radium-content of Sea Water.* **J. Joly.** (Phil. Mag. 18. pp. 396–407, Sept., 1909.)—The author here discusses at length the difference between his own results for the radium-content of sea-water [see Abstract No. 418 (1908)] and those of Eve [Abstract No. 1412 (1909)]. He points out that difference of acidification with HCl makes some difference to the amount of emanation obtained from any given sample. Eve made comparison between the mean of all Joly's determinations as given in his British Association address (16·0) and that of his own recent observations (0·9). Among the results included in Joly's mean are several high coastal values: omitting these the mean is 11·3. The mean of Joly's observations for across-Atlantic water is—if filtration results be excluded—6·7. Many measurements range about 4 to 7. One is as low as 2·2. Such may be regarded as from 3 to 7 times those of Eve. From the results of Knoche, using Rutherford and Geiger's result that in 1 gm. of radium $3{\cdot}4 \times 10^{10}$ atoms break up per sec., Joly calculates the mean amount of Ra present in the samples tested to be 17×10^{-12} gm. per litre, which is in moderately good agreement with his own results. A. W.

REFERENCES.

1707. *Range-finder Tests in America.* (Engineering, 86. pp. 827–828, Dec. 18, 1908. From Journ. of U.S. Artillery, 30. No. 3.)—An account of tests carried out by the U.S. Artillery Board. Of the three makes of range-finder ("coincidence" type) tested, that of Barr and Stroud was found to be by far the most accurate. L. H. W.

1708. *Binoculars with Weak and Medium Magnification.* **O. Henker** and **M. v. Rohr.** (Zeitschr. Instrumentenk. 29. pp. 280–286, Sept., 1909. Communication from the Optical Works of C. Zeiss.)—A discussion of the properties of prism binoculars. L. H. W.

1709. *Pressure of Light on Spheres of Specified Material.* **P. Debye.** (Ann. d. Physik, 30. 1. pp. 57–136, Aug. 31, 1909. Extract of Dissertation, München.)—A mathematical paper on radiation-pressure by the electromagnetic theory with special reference to the theory of Arrhenius of comet's tails. E. H. B.

17 0. *Relation between Absorption Spectra and Chemical Constitution.* Part XIII. *Some Pyrones and Allied Compounds.* **E. C. C. Baly, J. N. Collie,** and **H. E. Watson.** (Chem. Soc., Journ. 95. pp. 144–158, Feb., 1909.)

HEAT.

1711. *Mechanical Equivalent of Heat.* **H. T. Barnes.** (Roy. Soc., Proc. Ser. A. 82. pp. 390–395, July 26, 1909. Electrician, 63. pp. 749–750, Aug. 20, 1909. Abstract.)—Recent investigations have shown that the value of the Clark cell used by Callendar and Barnes in their determination of the mechanical equivalent of heat in 1902 was too high, and consequently a modification of the previous results is necessary. The author here discusses the corrections to be applied, and arrives at the results shown in the following table; the last column gives the values obtained by Rowland by the direct mechanical method between 5° and 35° C. as corrected by Waidner and Mallory.

Temperature, °C.	J. (Clark 1·4342).	J. (Clark 1·4330).	Rowland.
5	4·2105	4·2052	4·206
10	4·1979	4·1926	4·196
15	4·1895	4·1842	4·188
20	4·1838	4·1785	4·181
25	4·1801	4·1748	4·176
30	4·1780	4·1727	4·174
35	4·1773	4·1720	4·175
40	4·1773	4·1720	—
45	4·1782	4·1729	—
50	4·1798	4·1745	—
55	4·1819	4·1766	—
60	4·1845	4·1792	—
65	4·1870	4·1817	—
70	4·1898	4·1845	—
75	4·1925	4·1872	—
80	4·1954	4·1901	—
85	4·1982	4·1929	—
90	4·2010	4·1957	—
95	4·2038	4·1985	—
Mean...	4·1888	4·1835	4·185

The mean of the corrected results from 5° to 35° C. is 4·1826. Reynolds' and Moorby's mean value, as corrected by Smith, is 4·1836 for the range 0° to 100° C., as compared with 4·1849, which is the value the author obtains, allowing for the increase at both ends of the temperature range. The value of the 15° calorie obtained is 4·184. Rowland gives 4·188, while Reynolds' and Moorby's value (assuming the variation of the specific heat) is 4·183.

A. W.

1712. *Boiling-points of Metals.* **H. C. Greenwood.** (Roy. Soc., Proc. Ser. A. 82. pp. 396–408, July 26, 1909.)—The following boiling-points on the optical scale are given: Al 1,800°, Sb 1,440°, Bi 1,420°, Cr 2,200°, Cu 2,310°, Fe 2,450°, Pb 1,525°, Mg 1,120°, Mn 1,900°, Ag 1,955°, Sn 2,270°. The samples were heated in a carbon crucible in a tube resistor furnace; the crucible was brasqued with magnesia for metals which interact with carbon.

Some determinations were made in a furnace with a central resistor to eliminate any error due to radiation from the walls of the surrounding tube. The optical pyrometer was sighted on the side of the crucible. The commencement of agitation of the surface, decided ebullition, and violent ebullition were generally recognisable. The determinations were made in hydrogen or nitrogen atmospheres ; the readings were usually higher in nitrogen than in hydrogen. F. R.

1713. *Specific Heats of Argon, Aqueous Vapour, Nitrogen and Hydrogen at very High Temperatures.* **M. Pier.** (Zeitschr. Elektrochem. 15. pp. 536–540, Aug. 1, 1909. Physikal.-chem. Inst. d. Univ., Berlin.)—The author has determined the specific heats of argon, aqueous vapour, nitrogen and hydrogen by the explosion method [see Abstract No. 1341 (1908)]. The bomb used had a capacity of 35 litres, and the pressure produced by explosion was measured by the deflection of a corrugated steel membrane. Attached to the membrane was a mirror, and the amount of the deflection was measured by a mirror and scale arrangement, the records being made photographically. When the temperatures due to the explosion rose above 1,700° C. the maxima in the curves showing the relation between pressure and time were always sharp points, and in making the calculations no corrections were applied. The molecular specific heats at constant volume between 0° and 2,850° C. were found to be given by the following equations : Aqueous vapour, $C_v = 6{\cdot}065 + 0{\cdot}0005t + (0{\cdot}2/10^6)t^2$. Nitrogen, $C_v = 4{\cdot}900 + 0{\cdot}00045t$. Hydrogen, $C_v = 4{\cdot}700 + 0{\cdot}00045t$. For the monatomic gas, argon, C_v was found to be equal to 2·977, which is in very good agreement with the theoretical value 2·981. The results for nitrogen and aqueous vapour are compared with those of Holborn and Henning [Abstract No. 1858 (1907)]. T. S. P.

1714. *Determination of Specific Heat at Low Temperatures.* **A. Eucken.** (Phys. Zeitschr. 10. pp. 586–589, Sept. 1, 1909. Physikal.-chem. Inst. d. Univ., Berlin, 1909.)—In the method here used the substance itself acts as the calorimeter. Three powders, HgCl, $PbCl_2$, and AgCl, are experimented with. These powders are placed in a copper vessel, which is enclosed in a specially constructed vessel, carefully planned so as to avoid loss of heat by radiation ; this is in turn placed in a Dewar flask in which is contained liquid air, alcohol + CO_2, or water at the temperature of the room, according to the temperature required. The heating is arranged by passing a current through a Pt wire, and the same wire serves as a means of indicating the temperature. Full details are given of the method of carrying out the experiments by which the following results are obtained :—

Substance.	Mean Temperature, °C.	Mean Molecular Heat.
HgCl	17·5	11·43
HgCl	− 67·5	10·70
HgCl	−168·2	9·46
$PbCl_2$	17·5	18·32
$PbCl_2$	− 67·5	17·41
$PbCl_2$	−166·5	14·90
AgCl	− 65·5	11·81
AgCl	−157	10·84

The capacity for heat of the empty vessel was 90 per cent. that of the HgCl, 45 per cent. that of $PbCl_2$, and 35 per cent. that of the AgCl used. The deviation of the given mean values from individual results are only in a very few cases greater than 1 per cent. A. E. G.

1715. *Determination of the Saturation Pressure of Water-vapour below 0°.* **K. Scheel** and **W. Heuse.** (Ann. d. Physik, 29. 4. pp. 723–737, July 6, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—The statical method is adopted to determine the vapour pressure of ice down to —68° and that of water between the limits 0° and —16°. For the measurement of the pressure use was made of a Rayleigh tilting manometer, and the temperature was obtained by means of a platinum thermometer. The authors find for the vapour pressure at 0° the value 4·5788 ± 0·0006 mm., which is in good agreement with that of Thiesen and Scheel, viz., 4·579 ± 0·001 mm. A table is given in which the observed results are compared with those calculated according to the logarithmic formulæ of Hertz: there is no consistent agreement. Thiesen has shown that the difference between the saturation pressure of water and ice should attain a max. value, and calculates the corresponding value of the temperature as —11·7°. This is borne out well by the results obtained by the authors. W. C. S. P.

1716. *Vapour Pressure of Ice.* **M. Thiesen.** (Ann. d. Physik, 29. 5. pp. 1057–1062, Aug. 10, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—A discussion of the results obtained by Scheel and Heuse [see preceding Abstract]. The connection between the vapour pressure of ice and its temperature as given by the author is $\log (p/p_0) = Ct/T$, where p_0 is the vapour pressure of ice at 0°, and p the vapour pressure at t° C., or T° absolute. The value of log C is determined in the case of the results of Scheel and Heuse. That this is not a constant may be due to errors either in the measurement of the pressure, the temperature, or both. However, for calculations the formula $\log (p/p_0) = 8{\cdot}891\, t/(252 + t)$ is found to agree with the experimental results. W. C. S. P.

1717. *Thermodynamic Treatment of certain Properties of Water.* I., II., and III. **W. Nernst.** (Deutsch. Phys. Gesell., Verh. 11. 15. pp. 313–327, Aug. 15, 1909. From the physikal.-chem. Inst. d. Univ., Berlin.)—I. The deviations of water-vapour from all the gaseous laws are attributed to the formation and decomposition of double molecules. Consideration of previous results gives the value 2,519 gm.-cals. for the heat evolved during the change $2H_2O = (H_2O)_2$. For the vapour pressure p' of simple water molecules between 0° and 100°, the author deduces the following formula—

$$\log p' = \log p + \log[(1 + \gamma)/2\gamma] = -29363{\cdot}9/T - 4{\cdot}94 \log T + 23{\cdot}44837,$$

where p is the total vapour-pressure and γ, the degree of dissociation of water-vapour, has the values 0·99896 at 0°, 0·99830 at 10°, 0·99730 at 20°, 0·99595 at 30°, 0·99400 at 40°, 0·99178 at 50°, 0·98818 at 60°, 0·98403 at 70°, 0·97895 at 80°, 0·97280 at 90°, and 0·96550 at 100°. This formula gives results in good agreement with those obtained experimentally. The heat of evaporation of water into simple molecules is given by the expression—

$$\lambda' = (18422 - 9{\cdot}806T)(1 - v'/v_0),$$

where v' is the volume of the simple vapour and v_0 that of liquid water, the actual heat of evaporation differing from λ' by the heat of association of the double molecules formed in the vapour. At about 40° the specific heat of water-vapour at constant pressure is 8·19. The vapour-pressure curve for ice is calculated, the expression $11{,}938 + 3{\cdot}5T - 0{\cdot}0096T^2$, for the heat of evaporation of ice, agreeing well with the curve and giving for $T = 273{\cdot}09$, the value 12,178 which is in good accord with the experimental value. By means of a sensitive metal manometer the author has obtained for the vapour pressure of ice, the values: 0·291 at −30°, 0·0962 at −40°, and 0·0301 at −50°, which are in good agreement with those obtained by Scheel and Heuse [Abstract No. 1715 (1909)]. An interpolation formula for the vapour pressure of water at low temperatures is calculated. II. **H. Levy.** (Ibid. pp. 328–335, Aug. 15, 1909.)—II. For dissociating gases, the equation of state is: $\log[\gamma^2\delta P/(1-\gamma^2)T] = -Q/RT + \text{const.}$, where δ is the observed density of the vapour and γ the degree of dissociation; substituting 2519 for Q and 0·1384 for the const. [see above], the equation obtained is in good agreement with the observed values for water-vapour. This equation is used for calculating the true molecular heat of water-vapour at constant pressure, the numbers obtained agreeing with the observed values, especially for high temperatures and pressures. A table is given showing the densities of water-vapour at the pressures 1–8 atmos. and temperatures 100–500°, the densities of saturated water-vapour from 0 to 180°, and the molecular heats of water-vapour for the molecule $(H_2O)_2$ at 100–500° and 0–20 atmos. III. **W. Nernst.** (Ibid. pp. 336–338, Aug. 15, 1909.)—III. Nernst gives a *résumé* of the two preceding parts [see above], and gives explanations of the complicated variation of the specific heat of liquid-water, and of the minimal specific heat exhibited by water-vapour when heated at constant and not too low pressure. T. H. P.

1718. *Danger of Explosion of Compressed Oxygen and Hydrogen.* **L. Lucas.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1270–1271, Aug. 7, 1909.)—The adiabatic compression of a mixture of hydrogen and oxygen when escaping through the passages beyond the valve of the cylinder may raise the temperature sufficiently to cause explosion. Calculating the temperature-rise a comparison with published data indicates that hydrogen containing over 5·5 per cent. oxygen is explosive at temperatures which could possibly be obtained in the escape of gas under pressures used. At least 8·5 per cent. of hydrogen would have to be contained in a cylinder of oxygen before any risk of explosion could occur. Care should be taken to avoid the presence of oil or any other combustible material in the valve or pressure gauge, and the valves should be opened with due care. F. R.

1719. *Theory of the Greenhouse.* **C. G. Abbott.** (Phil. Mag. 18. pp. 32–35, July, 1909.)—In a previous paper [see Abstract No. 493 (1909)] Wood states that he has compared two "hot-boxes," one having a glass cover, the other a cover of rock-salt, but otherwise similar. A glass plate was interposed in the path of the sun's rays. A max. temperature of about 55° C. was observed within each box when exposed to the sun. Wood concluded that the function of the cover is mainly to prevent the loss of heat by convection, rather than the escape of long-wave rays. From theoretical considerations Abbott finds that a salt cover is nearly as efficient as a glass one, and he suggests possible reasons why Wood observed no difference at all. With regard to the effect of trapped radiation on the temperature of a planet as affected by its atmosphere, Abbott considers the case to be quite different from that of a "hot-box," as, according to the experiments of Langley, Rubens, and Aschkinass, the water-vapour of the atmosphere absorbs over 90 per cent. of the radiation from the earth's surface, so that it can be considered as practically a "black body" for rays of great wave-length. Hence he concludes that the atmosphere is important as a trapping agent to increase the earth's surface temperature. A. W.

1720. *Determination of the Calorific Value of Combustible Gases.* **P. Lemoult.** (Comptes Rendus, 149. pp. 454–456, Aug. 30, 1909.)—The author has worked out the details of a simplified method and apparatus for determining the calorific value of combustible gases. The method is based upon the fact that carbon monoxide and hydrogen gas (1) give the same contraction in volume when burnt, and the products of combustion are absorbed by an alkali, and (2) produce nearly the same number of heat calories, by their combustion, the figures being 68 and 69 respectively. It is unnecessary, therefore, in a gaseous mixture containing only carbon monoxide and hydrogen as combustible elements, to determine separately the percentage of these two gases, but the calorific value of the gas P can be calculated by means of the following formulæ—

$$P = \frac{68600}{2V} \cdot \frac{2a}{3} = 2049a = 6147b,$$

in which *a* represents the contraction after combustion of the gas in presence of an alkali, and *b* represents the volume of oxygen required for the combustion, and 2V is taken as equal to 22·32 litres at 760 mm. and 0° C. When methane is also present in the gas mixture, the same simplified method can still be applied, for if x, y, and z represent the volume percentages of hydrogen, carbon monoxide and methane respectively, the contraction after combustion over alkali (a), and the oxygen equivalent of the combustion (b), are given by the following equations—

$$a = 1{\cdot}5(x + y) + 3z, \quad \text{and} \quad b = 0{\cdot}5(x + y) + 2z,$$

which, by the application of algebraic methods, yield—

$$x + y = 4/3a - 2b\,; \quad z = b - a/3\,; \quad x + y + z = a - b.$$

The calorific value of methane is 213·2 cals. and the calorific value (P) of the gas mixture containing methane is therefore $P = (1/2V)\,(x + y)\,68{\cdot}6 + 213{\cdot}2z$, or more simply, $P = 0{\cdot}914a + 3{\cdot}405b$. For gas mixtures containing, in addition to methane, ethylene, benzene, and acetylene, the last formula gives only approximate results; but the error is unlikely to exceed 2 per cent. Some practical examples are finally given, showing the closeness of the calorific values calculated by this method and those obtained by direct trial, and the description of the apparatus devised by the author for determining easily and quickly the values of *a* and *b* is promised in a later communication.

J. B. C. K.

REFERENCE.

1721. *Pressure of Saturated Vapour from Water and Ice.* **C. F. Marvin.** (Monthly Weather Rev., Washington, 37. pp. 3–9, Jan., 1909.)—Discusses Ekholm's work [see Abstract No. 98 (1909)] and compares his results with those of earlier workers. L. H. W.

SOUND.

1722. *Phase of Harmonics and Acoustic Quality.* **M. G. Lloyd** and **P. G. Agnew.** (Elect. Rev. and West. Electn. 55. pp. 487–489, Sept. 11, 1909.)—Ever since the celebrated controversy between Helmholtz and König concerning the influence of the phase of harmonics, this question has remained a point of dispute between the supporters of these two great experimenters. Each of them had conducted experiments which apparently supported his case, König finding that the quality was affected by phase displacement of a harmonic, while Helmholtz found no effect. Helmholtz, to change the phase, shaded the aperture of the resonator used to reinforce the sound. This changed the amplitude as well as the phase of the vibration, and necessitated a compensating correction by altering the distance between fork and resonator. It is thus evident that the change from one condition to another could not be made with much rapidity. König's experiments were made with the wave siren, which has since been shown (R. König, Wied. Ann. 57. p. 339, 1896; C. Stumpf, Wied. Ann. 57. p. 677, 1896) to give small quantities of extraneous harmonics. The present authors accordingly regard both researches as undecisive. The experiments here described made use of electrical currents whose wave-form could be controlled, a telephone receiver being used to transform these into sound waves. Definite composition of the electrical wave was made possible by the use of a special set of generators at the Bureau of Standards, known as the *Harmonic Set.* This set consists of two driving motors and eight three-phase generators, which, at normal speed, give frequencies of 60, 180, and 300 (mounted on the shaft of one motor) and 420, 540, 660, 780, and 900 cycles per sec. (mounted with the second motor). The two sections could be coupled rigidly when required. To shift the phase in the best possible way use was finally made of a second motor-generator set. By taking the fundamental from one and the harmonics from the other, and then running the machines just out of synchronism, we have one wave-train slowly drifting relatively to the other, thus producing a slowly and periodically recurring change of phase. The effect was much the same as in the arrangement used by Kelvin (Roy. Soc., Edin., Proc. 9. p. 602, 1878), who took two tuning-forks, one of which was an exact harmonic of the other, and changed the period of one very slightly by adding a small weight to it, thus giving a continuous cyclic change of phase. In the present experiments great difficulty was experienced in eliminating spurious effects. Thus, while the method is very sensitive, the authors consider that positive results should be accepted only after care has been taken to ensure that no disturbing factors are present. The ideal condition for its use would be to have the machines in separate buildings, and the observer in a third. The experiments clearly support Helmholtz's view that quality is independent of phase relations, as was found by Kelvin with his analogous mechanical drifting-phase method. They also show that the telephone introduces both the odd and even harmonics which are not present in the voltage wave at its terminals, or in the current wave through it. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1723. *Theory of Rigid Electrons and Relativity Principle.* **M. Born.** (Ann. d. Physik, 30. 1. pp. 1–56, Aug. 31, 1909.)—A highly analytical paper divided into three parts dealing respectively with the kinematics of the rigid body, the field of the rigid electron in hyperbolic motion and the dynamics of the same. It is shown that the theory accounts for the deflection of electrons in electric fields which are not changing too quickly in time or place. On the other hand, it does not in all cases apply for magnetic deflections. E. H. B.

1724. *Initial Velocities of Electrons liberated by Ultra-violet Light.* **A. W. Hull.** (Amer. Journ. Sci. 28. pp. 251–259, Sept., 1909. Contribution from the Sloane Physical Laboratory of Yale College. Phys. Zeitschr. 10. pp. 537–542, Aug. 15, 1909. From the English.)—Measurements were made of the initial kinetic energies of the electrons liberated from carbon by light between $\lambda = 1710$ and 1230 Å.U. The results showed an agreement with the law of proportionality discovered by Ladenburg. That is to say, the square root of the max. initial kinetic energy is proportional to the frequency of the liberating light, at any rate to the accuracy with which this part of the spectrum is known. We can now say that in the whole region from $\lambda = 2700$ to 1230 Å.U. the max. initial velocities of electrons are proportional to the frequencies of the lights which have liberated them. [See also Abstracts Nos. 1883 (1902) and 1891 (1907).] E. H. B.

1725. *History and Present Position of the Fundamental Electric Units.* **P. Janet.** (Journ. de Physique, 8. pp. 529–571, Aug., 1909. Soc. Franç. Phys., Bull. 1. pp. 72–94, 1909.)—The author first gives a history of the various conferences which have been held in connection with the fundamental units and a short *résumé* of the results obtained. He then discusses the ohm, the ampère, and the volt individually. The legislation in various countries concerning these units is given. In many cases it seems to have been drawn up too hastily. France is commended for having contented itself with a simple decree which can be easily amended at any time. The author makes a plea for patience. There are obvious drawbacks to rushing hasty and ill-considered resolutions through at Conferences. A. R.

1726. *Researches in Electrostriction.* **L. Bouchet.** (Journ. de Physique, 8. pp. 650–670, Sept., 1909.)—By electrostriction is meant the deformation of solid dielectrics due to the influence of the electrostatic field. The author has made researches on the phenomena with dielectrics which stick to the electrodes, and his results are in good agreement with those obtained by Cantone. But with dielectrics which do not adhere to the electrodes the problem is vastly more complicated. Various experimenters have attempted to determine the variation of the dielectric coefficient produced by the electrostatic strain, but with unsatisfactory results. In this paper the author criticises the methods used and finds accurate mathematical formulæ from which the errors due to the unavoidable errors in centreing, &c., can be computed. For example, in order to explain More's results it is only necessary to suppose that the axis of the inner cylinder was the hundredth part of a cm. from its symmetrical position. The author will shortly publish experimental results he has obtained. **A. R.**

1727. *Dispersion of Electricity.* **A. Campetti.** (Accad. Sci. Torino, Atti, 4. 10. and 11. pp. 848–860, 1908–1909.)—The dispersion of electricity has been measured, in the Valley of the Ticino, at about 1,000 m. above sea-level, between July 26 and Sept. 24, 1908, observations being made at 10 h. and 17 h. almost every day. This valley is very narrow and shut in by mountains, so that the terrestrial field may be regarded as practically zero. An apparatus of the Elster and Geitel type, with Gerdien's electroscope, was used for determining the dispersion, the velocity of the wind around the instrument being reduced to about 100 m. per min. Tables are given of the results, together with the temperature, hygrometric state, direction and velocity of the wind, and general weather conditions. It is concluded that on a rainless day the concentration of the positive ions is practically always greater than that of the negative ions. The numbers of both positive and negative ions are diminished on a rainy day, the coefficient of dispersion being usually greater for positive electricity than for negative. In this case probably the effect of the relative humidity as well as of the rain should be taken into account, the rain causing an excess in the air of negative ions, while, owing to increase in the relative humidity, the concentration of the negative ions is diminished. No direct relations between the velocity and direction of the wind, and the coefficients of dispersion is apparent, but high values for the coefficient of dispersion occur more frequently with greater wind velocities. No relation exists between the ratio of the coefficients of dispersion of positive and negative electricity, and the magnitude and sign of the fall of atmospheric potential. **W. H. Si.**

DISCHARGE AND OSCILLATIONS.

1728. *Mobility of Ions in Vapours.* **K. Przibram.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 331–360, March, 1909. II. Phys. Inst. d. k.k. Univ., Wien.)—The previous paper [Abstract No. 507 (1909) gave for ion-mobilities in vapours values too low, which should be multiplied by 1·3. Coefficients of recombination in water, ethyl alcohol, and isoamylalcohol vapours are given, which agree well with the ion-mobilities. Ion-radii, computed by Lenard's formulæ, give saturations corresponding to condensation which agree well with the results of T. H. Laby from expansion experiments. The expansion requisite for condensation on ions in water-vapour varies little between —10° C. and + 29° C., whence we may infer approximate constancy of the ion-radius within these limits. Condensation experiments with water-alcohol mixtures give a minimum of necessary supersaturation for a given concentration—a relation which confirms the theory with respect to the dependence of superficial tension on the concentration. An attempt is made to compute the mean ionic mobility in a mixture from the mobilities of the two components. **A. D.**

1729. *Electric Conductivity of Salted Flames.* **U. Gouttefangeas.** (Annal. Chim. Phys. 17. pp. 515–525, Aug., 1909.)—The results of the author's experiments lead to the following conclusions: Solutions, of equal molecular concentration, of salts of one and the same alkali or alkali-earth metal, when introduced into a flame, impart to the latter conductivities which are approximately equal but which increase slightly with the molecular weight of the salt. The metal has hence a predominating effect, that of the acid radical being usually less than 0·01 of the effect due to the metal. For one and the same salt the conductivity increases with the concentration according to a law apparently more complicated than that of Arrhenius (Wied. Annalen, 1891) or that of Wilson [Abstract No. 1079 (1900)], although in some cases one of these laws is approached, and in other cases the other law. Assuming that the flame is the seat, not only of kathodic ionisation, but also of a slight electrolytic dissociation analogous to that produced when a dilute solution traverses a tube at red heat, it is evident that the conductivity, resulting from the sum of the two actions, cannot vary according to a simple law. Organic salts, in general, behave like mineral salts, but impart to the flame slightly lower conductivities. T. H. P.

1730. *Ionisation in the Ether Flame.* **De Muynck.** (Annal. Soc. Sci. de Bruxelles, 33. 3. and 4. pp. 196–200, 1909.)—Two insulated metallic plates are placed about 1 cm. apart in the interior of a large lead tube, in which an explosive mixture of ether and oxygen, or ether and air is placed. In circuit with the two plates are put two accumulators and a very sensitive galvanometer. At atmospheric pressure the instant the mixture is exploded by means of an electric spark the circuit closes and a deflection of the galvanometer takes place, but when ether is burned in air between the same electrodes no deviation is noted. At lower pressures a much smaller deflection takes place on exploding the mixture, so that it appears as if the ether flame produced by explosion is ionised. A. E. G.

1731. *The Ions of Gases.* **W. Sutherland.** (Phil. Mag. 18. pp. 341–371, Sept., 1909.)—Recent accumulations of experimental work on this subject show the need of a more comprehensive theory than has yet been advanced. This paper is an attempt to state the fundamentals of a theory wide enough to contain the chief phenomena now known. The simplest theoretical ion in a gas is an atom charged with an electron, just as in electrolytic solutions. But the calculations of J. J. Thomson, Langevin, and others, seem to show that the smallest ions in gases consist of a few molecules, say two or three. P. Phillips, in his experiments on *Ionic Velocities in Air*, with a wide range of temperature, finds the number of molecules in a gaseous ion to vary apparently with the temperature. It is here shown that this variation of the size of the ion in gases is only apparent; that the experimental ion is the simple ion of theory and electrolysis; and that the seeming change of size is due to the same cause as the seeming change of size of molecules with temperature in the viscosity of gases and allied phenomena before the effects of cohesional force were allowed for in the kinetic theory of gases. When the electric force of the simple ion in a gas is introduced into the calculation of the ionic mobilities to be expected at the different temperatures in the experiments of Phillips, it removes all necessity for ascribing varying complexity to that ion. Denoting by *mobility* of an ion its velocity in cm. per sec. under an electric force of 1 volt per cm., gaseous ions are here divided into three classes, those having at about 15° C. mobilities of the order 2, 0·02, and 0·002. No doubt these types verge continuously each into the next. They are also specified as follows: Let the ion formed of atom and electron be called a nucleolus, such an ion surrounded by molecules forming a solid or liquid mass be called a nucleus, and let a collection of molecules in the form of a vapour round a nucleus or nucleolus be called an envelope; then the three types of gaseous ion are (1) nucleolus alone, (2) nucleolus and envelope, and (3) nucleus and envelope. The third type merges into the visible drop of fog and rain, though it is probably distinguished from these by the fact that the majority of the molecules in the nucleus and envelope are more directed by central electric force from the electron than by the mutual cohesional forces. In this dynamical theory of the ions of gases the two new types of viscosity previously investigated for ions in electrolytic solutions are found to be of paramount importance. [See Abstract No. 1740 (1907).] E. H. B.

1732. *Photoelectric Properties of Sodium-Potassium Alloy.* **J. Kunz.** (Phys. Rev. 29. pp. 174–176, Aug., 1909.)—Experiments are carried out in order to ascertain the influence of the plane of polarisation and the angle of incidence on the initial velocity of the electrons, and on the number of electrons emitted from unit surface in unit time. A Nicol prism is introduced between the arc and the Na-K alloy, so that the long diagonal of the end surfaces is horizontal, and thus the light incident on the metal is polarised in a plane at right angles to the plane of incidence: the result is the same as when the prism is absent. The angle of incidence is 55°. The positive potential, however, decreases 84·3 per cent. when the plane of polarisation is turned from the position where it is perpendicular to that in which it is parallel to the plane of incidence. The experiment is repeated with ultraviolet light of special wave-length, and the same result obtained. The results taken in conjunction with those obtained by Elster and Geitel indicate that the number of electrons emitted must be affected very considerably by the plane of polarisation. The influence of temperature upon the positive potential acquired by the alloy is tested, and it is found that it does not increase with increasing temperature; there is, rather, a slight decrease of the deflection, due probably to increasing conductivity of the surface of the glass wall of the photoelectric cell. A. E. G.

1733. *Photoelectric Effect with Polarised Light.* **R. Pohl.** (Phys. Zeitschr. 10. pp. 542–543, Aug. 15, 1909. Physikal. Inst. d. Univ., Berlin, July, 1909.)—In the case of solid metals sensitive to light of short wave-length the author has observed the dependence of the emission of electrons on the azimuth and angle of incidence of the polarised light. The experiments were performed with a high vacuum, and without using an accelerating electric field. The mirror surfaces of Leithäuser were made use of. Details are given in the case of platinum. J. J. S.

1734. *Photoelectric Effect on Platinum and Copper by Ultra-violet Light.* **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 11. 16. pp. 339–359, Aug. 30, 1909. Physikal. Inst. d. Univ., Berlin, July, 1909.)—The apparatus used is described in detail, and tables and curves showing the experimental results are given. The chief results are as follows: With mirrors of Pt and Cu there is a considerable dependence of the number of electrons emitted, upon both the azimuth and the incident angle of the polarised ultra-violet light. The distribution of velocity is independent of the polarisation conditions. For light polarised parallel to the plane of incidence there is a proportionality between the photoelectric current and the absorption of light as calculated from the optical constants; the same is true for light polarised at right angles to the plane of incidence. The proportional factor is the same for the chief points of the azimuth with different angles of incidence. This is not in agreement with results obtained with Na-K alloy, for which substance it is 80 times greater when the electric vector is in the plane of incidence than when the vector is at right angles to that plane [see Abstract No. 1782 (1909)]. The difference between the behaviour of the fluid alkalies sensitive to ordinary light, and solid metals sensitive to ultra-violet light, may be that in the former the electrons are "free" to follow the electric vector, while in the latter the ultra-violet light is absorbed by "bound" electrons. A. E. G.

1735. *Electric Arc between Metallic Electrodes.* **W. G. Cady** and **G. W. Vinal.** (Amer. Journ. Sci. 28. pp. 89–102, Aug., and pp. 239–250, Sept., 1909. Phys. Zeitschr. 10. pp. 569–576, Sept. 1, and pp. 628–630, Sept. 15, 1909.)—In a previous paper [see Abstract No. 115 (1908)] it was shown that when the current between metallic electrodes was small it was very unsteady. The authors first discuss the theory. A knowledge of the statical characteristic enables the point where the discharge changes from the arc to the glow to be rapidly located. It is pointed out that the effective value of the alternating current may be greater than that of the direct current supplied by the generator. The frequency is sometimes of the order of a quarter of a million. The pulsating discharge, which may be called the "glow-arc" discharge, is a spontaneous and rapid change backwards and forwards between arc and glow. A striking feature is that the power expended at the kathode on the glow phase is greater than on the arc phase. With suitable arrangements the frequency of these oscillations is in synchronism with the free period of the neighbouring portion of the discharge circuit. The copper arc in air gives pulsations slow enough to be recorded on a photographic plate, but the oscillations are most rapid and powerful when the discharge takes place in a mixture of hydrogen and acetone vapour. The measurement of the max. p.d. assumed by the discharge during each cycle affords strong evidence in favour of the glow arc hypothesis. By means of a calibrated spark-gap it was found that this maximum does not rise above the corresponding characteristic of the glow discharge. A novel method was employed for keeping the gas in the neighbourhood of the spark-gap in a state of ionisation. Apparatus suitable for producing glow-arc oscillations of high frequency is described; either direct or alternating current may be used. A number of experiments are described using glow-lamps or hot-wire ammeters, demonstrating some of the effects of these high-frequency currents. Under favourable circumstances 66 per cent. of the energy supplied to the discharge can be converted into oscillating currents. By means of a tuned resonating circuit the presence and relative intensities of a large number of high harmonics were investigated. Observations of damping were carried out with difficulty, but they indicate that the oscillations are undamped. The quantity of matter volatilised per cycle at the kathode on the arc phase was measured. When a capacity and self-inductance are connected in parallel with the discharge the oscillations are diminished. Experiments are described that illustrate the radiation of electromagnetic waves from the discharge and from the portions of the circuit adjacent to it. A. R.

1736. *Production of Positive Rays by Ultra-violet Light.* **H. Dember.** (Ann. d. Physik, 30. 1. pp. 137–165, Aug. 31, 1909. Physikal. Inst. d. techn. Hochschule, Dresden, July, 1909.)—A full description with diagram is given of the apparatus, and details of the experiments are shown in various tables and curves. The following are the chief results obtained. In photoelectric phenomena not only electrons and negative carriers but also positive rays are produced. These positive rays are of two distinct kinds: (1) The inner positive rays, so far as can be judged from the present research, consist of metal ions having absorbed a certain amount of energy from the light which falls upon the metal, and leave the latter with a velocity which lies between 0 and 5 volts. (2) There also originate through collision of the accelerated photoelectric kathode rays with the residual gas, when the p.d. is more than 7 volts, positive rays—the outer positive rays. For these, analogous conditions of existence apply as for the negative ions of the photoelectric discharge. It remains to be shown that the number of these positive ions reaches a maximum limit for a given pressure. The existence of these inner positive ions provides still further insight into photoelectric phenomena. When an insulated metal plate is illuminated with a suitable source of light, electrons and also positively charged ions proceed from the metal. A greater number of negative than positive charges succeed in leaving, so that the metal becomes positively charged. This positive charge reacts upon the negative charges, leaving the metal until the positive and negative charges leaving become equal to one another. A. E. G.

1737. *Recombination of Ions in Air at different Temperatures.* **P. Phillips.** (Electrician, 63. pp. 917–918, Sept. 17, 1909. Abstract of paper read before the British Assoc. at Winnipeg, 1909.)—Langevin has shown that McClung's original experiments on this subject were quite spoiled by diffusion, owing to the electrodes being too near together, and to the intense ionisation which existed at the surface of the electrodes. In the present experiments, Langevin's method of finding the recombination is adopted. The rays produced by a single discharge in a Röntgen bulb, ionise a layer of air between two parallel electrodes, one of which is connected with a Dolezalek electrometer, and the other raised to a definite potential. The parallel electrodes are about 8 cm. apart, and the layer of ionised air about 1·5 cm. thick, thus leaving spaces of about 0·75 cm. between the surfaces of the ionised layer and the electrodes. It is probable that diffusion may be neglected, but, in any case, more rapid diffusion would here make the recombination appear slower. The electrodes are surrounded by a jacket, through which vapours from liquids boiling at known temperatures may be circulated. The experiment consists, essentially, in measuring the charges received by the electrometer when different fields are established between the electrodes. This is done first at the temperature of the laboratory, and then at the temperature of the boiling-point. From a comparison of the two series of readings, the ratio of the coefficients of recombination at the two temperatures may be calculated. The results obtained up to the present are as follows:—

Temperature.	α	Erikson's Values.
15° C.	1·00	1·00
100°	0·50	0·51
155°	0·40	0·405
178°	0·36	0·38 (by extrapolation)

Erikson used Ra as source of ionisation and an entirely different experimental method when he obtained the above results. These differ from the results of McClung, which show an increase in the value of α, with increasing temperature. A. E. G.

1738. *Magneto-anodic Phenomena.* **Gouy.** (Comptes Rendus, 149. pp. 882–885, Aug. 9, 1909.)—A further study of the magneto-anodic crown in a Crookes tube [see Abstracts Nos. 686, 879 (1909)] provided with a metal plate which forms an earthed kathode. Two cases are studied: without and with an obstacle (a film of mica) in contact with the anode. In the latter case the crown spreads out, and presents appearances of sinuosity or zigzag lines of luminosity, as the original position is being regained. A suggested explanation, based on oscillations of the magneto-kathodic rays, considered as helicoidal whirls of electrons, is put forward. A. D.

1739. *Discontinuous Discharges in Tubes.* **J. Würschmidt.** (Deutsch. Phys. Gesell., Verh. 11. 14. pp. 800–809, July 30, 1909.)—Taking b as the length of the bluish glimmer about the kathode, and n as the number of sparks per sec., within certain limits $bn =$ const. The time of each discharge is b_0/bn, where b_0 is the value of b under continuous discharge. The product bn varies with the pressure p in the tube. The duration of each discharge grows with increase of a capacity put in parallel, but a spark-gap in series has little influence on the duration. The length b depends not only on the quantity of electricity passing per discharge, but also on the duration of each discharge. A. D.

1740. *The So-called Capacity of a Discharge Tube.* **J. Würschmidt.** (Deutsch. Phys. Gesell., Verh. 11. 16. pp. 860–868, Aug. 30, 1909.)—The so-called capacity of a discharge tube can be determined by connecting it in parallel with a known capacity. In tubes of the type used it is independent of the dimensions of the tube, and of the pressure also, within the observed limits. It depends on the resistance included between the tube and the source of electricity, so that an electrical machine or a battery can be used equally well. With moist air the capacity is greater than with drier air and with hydrogen. If the capacity in parallel is very great in comparison with that of the tube, the number of discharges passing through the tube per sec. is inversely proportional to the capacity in parallel. A. E. G.

1741. *Effect of Temperature Variations on the Luminous Discharge in Gases at Low Pressures.* **R. F. Earhart.** (Phys. Rev., 29. pp. 293–303, Sept., 1909. Paper read before the British Assoc. at Winnipeg, 1909. Electrician, 63. p. 918, Sept. 17, 1909. Abstract.)—The apparatus used consists of a small glass bulb in which two parallel electrodes 5 mm. apart are sealed. The bulb is contained in an electric furnace, which could also be used to contain solid CO_2 when desired. Potentials required to produce a luminous discharge for temperatures varying from —78° C. to 325° C., are measured. The gases used are air, hydrogen, and CO_2. Potentials needed to maintain the luminous discharge under similar conditions, are also measured. Curves showing effects of temperature and pressure for these potentials are constructed. They indicate that Paschen's law holds approximately for the discharge in air until temperatures of about 300° C. are reached. Here the law does not hold, even approximately. The effect of temperature variation on the potential required to maintain the discharge, is much less than for the production of the initial discharge. A. E. G.

1742. *Potential between Enveloped Electrodes.* **De Muynck.** (Annal. Soc. Sci. de Bruxelles, 33. 3 and 4. pp. 200–207, 1909.)—Glass bulbs containing a liquid conductor are connected to the poles of a Holtz machine, a micrometer with metallic balls being placed in circuit. The method adopted is to obtain a spark across the micrometer gap, then one across the gap between the special electrodes. The mean of these two positions is then considered equal to the distance for which a discharge should take place indifferently in the micrometer, or between the electrodes. The spark between the electrodes is not so strong as in the micrometer, the former discharge taking two distinct forms, for which it appears that a difference exists between the disruptive potentials; but this is not systematically studied. Tables are given which show that for a given value of the potential the length of the spark with the special electrodes is greater than when metallic balls are used, the deviation increasing with increasing length of spark-gap. A. E. G.

1743. *Induction Coil Discharge with a Spiral Spinterometer.* **I. Schincaglia.** (Elettricista, Rome, 8. pp. 225–228, Aug. 1, 1909.)—Experiments are described, in which a spiral spinterometer, consisting of four parallel copper solenoids, supported by glass tubes, is inserted between the electrodes, the two inner solenoids terminating, one in a disc, the other in a point. By utilising a special form of electrolytic interrupter, it is possible, in a semi-oscillation, to produce the multiform and ill-defined discharge obtained when one varies the explosive distance, the number of interruptions, and the intensity and e.m.f. of the inducing current. Illustrations are given of the discharges so produced. W. H. Si.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1744. *Effect of Magnetic Field on Selenium.* **L. Amaduzzi.** (N. Cimento, 18. pp. 58–62, July–Aug., 1909.)—Experiments, with the "three-way" method of Righi, on selenium deposited on copper wires, show that the Hall-effect is very marked, and probably negative, though further experiments are required to prove this. The resistance of selenium is increased by the magnetic field. An arrangement of metals in order of greatness of variation in resistance due to a magnetic field, is identical with an arrangement in order of rotatory coefficients, the following being such a series: Bi, Ni, Fe, Mg, Zn, Au, and Pt. Cd and Pd are apparent exceptions to this rule. The variation in resistance may be attributed not only to the displacement in lines almost coincident with the thermal or electric flux of the corpuscles, but also to the disturbance of the directive action of the electric or thermal current, which causes all the thermal and galvanomagnetic phenomena. W. H. Si.

1745. *Ionisation of Paraffin at different Temperatures.* **T. Bialobjeski.** (Comptes Rendus, 149. pp. 279–281, July 26, 1909.)—The author continues his investigations as to the effect of radiations upon the conductance of dielectrics [see Abstract No. 1599 (1909)]. In the present case the substance examined is hard paraffin (from ozokerit), and 1 mgm. of radium bromide, enclosed in mica, to exclude the action of the a-rays, is used as the source of radiation. It is found that for temperatures ranging from 20° to 100° C., the ratio of the spontaneous current to the ionisation current, is practically constant (11·5 to 18·7, mean 15·1). The variation in the current with the temperature is attributed to changes in the mobility of the ions. By a method analagous to that of Böhm-Wendt and v. Schweidler, the author has determined the sum of the mobilities of the ions of both signs which act as carriers of the spontaneous current. At 100° the value $5{\cdot}1\times10^{-4}$ cm. per sec. per volt per cm. is obtained; at 80°, 35×10^{-4}.

L. H. W.

1746. *Electrostatic Induction through Solid Insulators.* **H. A. Wilson.** (Roy. Soc., Proc. Ser. A. 82. pp. 409–421, July 26, 1909.)—This is an account of some work on ebonite, paraffin wax, and sulphur condensers. In each case the condenser was compared with a standard air condenser, and it is shown that, for a definite time of charging, the capacity is nearly independent of the applied voltage. The small variations which appear to occur may be due to slight temperature-changes or to the after-effects of the previous chargings. There is no reason to suppose that anything of the nature of true hysteresis exists. In the case of paraffin wax the capacity does not change appreciably with the time after charging. With ebonite and sulphur the capacity is a function of the time of charging and varies respectively from 5 to 20 per cent. in the course of half an hour. The author points out that such substances are therefore unsuitable for use as insulators in experiments in which exact electrostatic measurements are to be made, unless the total capacity is large compared with the capacity due to the insulation. The variation of capacity (at constant p.d.) with the time of charging t, is given approximately by the formula: $C = C_0[1 + B\log(1 + pt)]$, when B and p are constants.

W. C. S. P.

1747. *Measurement of Dielectric Constants by the Oscillations of Ellipsoids and Cylinders in a Field of Force.* **W. M. Thornton.** (Roy. Soc., Proc. Ser. A. 82. pp. 422–447, July 26, 1909.)—Ellipsoids and cylinders, accurately cut from crystals and other insulating material and having a mass not exceeding ½ gm. were suspended by a quartz fibre between brass plates connected to an alternating-current transformer, giving a sinuous electrification of 1,500 to 2,000 volts at a frequency of 80 to 85. The period of small swings of the bodies was observed, in a vacuum of about 700 mm. of mercury, with and without the field; from these measurements the dielectric constants could be obtained. The size of the plates and their distance apart were chosen after trial with the stream-line method. The p.d. between the plates could be raised to 10,000 volts, the voltage being read by means of a Duddell twisted-strip ammeter having a high resistance in series with it. It was necessary to calibrate the instrument with direct current before and after each set of readings with alternating current; in this way consistent results were obtained. Experiments were first conducted on ellipsoids of optical flint-glass of various densities and quartz cut parallel and perpendicular to the optical axis. For quartz the values of $K_\perp$, the coefficient of dielectric polarisation at right angles to the optical axis, and $K_\parallel$ the coefficient of longitudinal polarisation, work out to 4·548 and 4·600 respectively. These results are in good agreement with the values obtained from the optical data of the Ketteler-Sellmeier formula, viz., K (ord.) = 4·578; K (ext.) = 4·606. From experiments made on fused quartz it is shown that the influence of the crystalline structure in quartz on the dielectric constant is small compared with the influence of density. The author's results for flint glass of various densities agree well with those obtained by Hopkinson, except in the case of a light glass where there is a difference of 2·3 per cent. A number of substances, such as paraffin wax and shellac, which it is impossible to work, were prepared in the form of moulded ellipsoids and investigated. Some investigations were also carried out on cylinders. Certain liquids were investigated by enclosing in a cylindrical tube. Thus it was found that at 80 ∾ the dielectric constant of water is infinite. The paper concludes with a list of the results obtained compared with previous determinations. W. C. S. P.

1748. *Vaschy's or Pirani's Method of comparing Self-inductance with Capacity.* **C. H. Lees.** (Phil. Mag. 18. pp. 432–436, Sept., 1909.)—In connection with Silva's and Snow's papers [see Abstracts Nos. 470 (1907), 1290 (1909)] the author gives a complete discussion of the method. Using the mathematical expressions for the electro-kinetic energy and the dissipation function he writes down at once the equations for the flow of electricity in the various branches of the network. He then shows how the method can be extended to take into account e.m.f.'s occurring in the system by means of an artifice due to O. Heaviside. A simple inspection of the equations, without solving them, shows that $L - Kr^2 = 0$, is the necessary condition that the integral of the transient current through the galvanometer should be zero whether oscillations occur or not. The various practical points that have to be considered in addition are discussed. A. R.

1749. *Electric Contact Effect between Metals and Gases.* **A. Becker.** (Ann. d. Physik, 29. 5. pp. 909–940, Aug. 10, 1909. From the Phys. Inst. d. Univ., Heidelberg, June 5, 1909.)—It has been shown by Lenard [Wied. Annalen, 46. p. 584 (1892)] that when a gas comes into contact with a changing liquid surface, production of electricity occurs. The author has investigated this phenomenon in the case of mercury flowing in a fine stream through a vertical cylinder filled with the gas. The dried, purified gas enters at the top of the cylinder and, after leaving at the bottom, passes through a cotton-wool filter and then a cylindrical condenser. An electrometer connected with the filter shows the electric charge retained by the latter. By means of the condenser it is ascertained whether unipolar conduction occurs in the gas or whether electricity carriers of different signs have been formed. When the mercury stream falls on to an iron plate, with all the gases investigated—H, air, CO_2—the cotton-wool filter becomes positively charged, whilst the condenser exhibits the presence of carriers of both signs, the positive charges preponderating. When, however, the mercury falls on to mercury, the filter assumes a positive charge with hydrogen and a negative one with air or CO_2. Replacement of the iron plate by other metals is also accompanied by a change in the sign of the charge. The author explains these phenomena by supposing that, at the contact of mercury and gas, an electric double layer is formed, which charges the mercury positively towards CO_2 or air and negatively towards hydrogen. By constant renewal of the surface of contact, the charges present in the gas are carried away by the stream of gas. Such double layer is also formed at the surface of contact of a gas with a solid metal. Gases may therefore be arranged in Volta's series, which, according to the above and previous investigations, is as follows: + Zn, Al, H, Hg, air, CO_2, Fe, Cu, Pt —. The sign of the electrification is changed by the addition to the mercury of a small proportion of tin, zinc, or silver. T. H. P.

1750. *Mercurous Sulphate for Standard Cells.* **C. J. J. Fox.** (Electrician, 63. p. 835, Sept. 3, 1909. Abstract of paper read before the British Assoc. at Winnipeg.)—Describes a method of preparing large quantities of very reliable, well-crystallised, white mercurous sulphate suitable for standard cells. Commercially pure mercurous sulphate is heated together with a little pure mercury and dilute H_2SO_4 for a day or so at 120° to 150° in either a sealed tube or a bottle with wire-bound stopper. The mixture is occasionally agitated and the H_2SO_4 filtered off and renewed during the heating process. The resulting salt is finally ground up in a mortar with one or two successive quantities of diluted H_2SO_4 and then with several quantities of saturated cadmium sulphate solution; it is then ready for use. F. E. S.

1751. *Clark and Weston Standard Cells.* **H. L. Bronson** and **A. N. Shaw.** (Elect. Rev. 65. p. 337, Aug. 27, 1909. Chem. News, 100. pp. 149–150, Sept. 24, 1909. Electrician, 63. pp. 844–845, Sept. 3, 1909. Abstract of paper read before the British Assoc. at Winnipeg.)—This paper deals mainly with the accuracy and reproducibility of Clark and Weston cells. 15 Clark cells and 18 Weston normal cells were made; these were indirectly compared with the mean e.m.f. of the reference cells at the Bureau of Standards and directly compared with 5 Weston cells made at the National Physical Laboratory and which had travelled to Montreal, where the experiments were made. The mean e.m.f. of the 15 Clark cells differed from the Bureau of Standards' Clark cells by less than 14 microvolts. The mean of the 18 Weston cells differed from those of the Bureau of Standards by 4 microvolts, and from those of the National Physical Laboratory by 5 microvolts. Cells containing unpurified mercurous sulphate as depolariser had e.m.f.'s which were higher by from 300 to 500 microvolts than that of the normal cell. F. E. S.

1752. *Resistances with Low Self-induction.* **E. Orlich.** (Zeitschr. Instrumentenk. 29. pp. 241–256, Aug., 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—The resistances consist of a pair of sheets of manganin usually 0·5 mm. thick, insulated with silk when no special means of cooling, such as petroleum circulation, are adopted. The calculations for designing, and for measuring the self-inductance by Giebe's method, are given. The measured self-inductances of resistances of this type of from 1 to 0·001 ohm are given, and these are about $\frac{1}{8}$ of those of the old form of non-inductively wound resistance. F. R.

1753. *Magneto-elastic Detector.* **A. G. Rossi.** (Accad. Sci. Torino, Atti, 44. 15. pp. 666–684, 1908–1909. Atti dell' Assoc. Elettr. Ital. 13. pp. 323–361, May–June, 1909. Phys. Zeitschr. 10. pp. 549–553, Aug. 15, 1909.)—A lengthy discussion of the theory and construction of the apparatus dealt with in Abstract No. 687 (1908). The most extreme sensitiveness as a detector for wireless telegraphy is claimed, but no data are given which would enable any opinion to be formed as to this. It is found that the apparatus will give a deflection when convection currents are set up by rotating an ebonite plate (provided with tin-foil sectors) in a plane parallel to the wire connected to the apparatus. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1754. *Poles and Pole Strengths of Long Magnets.* **E. Salmon.** (Journ. de Physique, 8. pp. 579–594, Aug., 1909.)—A short magnetised horizontal needle acted on by the nearer pole of a long magnet placed vertically over its centre experiences a horizontal force $f = \mu m/r^3$...(1), where m is the magnetic moment of the needle, μ the pole strength of the magnet, and r the distance of the pole from the axis of the needle. If the forces f_1, f_2, f_3, &c., for distances r, $r+d$, $r+2d$, &c., are measured, then $d/r = \sqrt[3]{(f_1/f_2)} - 1$, &c.,...(2). Also from (1) by multiplying by λH^2 we get $H = \sqrt{(mHMH/r^2 f\lambda)}$...(4). Formulæ (1), (2), and (3) may be used to determine μ, the polar separation of the magnet, and H. The author explains how the various quantities involved may be accurately measured. The determination of f is the most difficult and has necessitated the designing of a special piece of apparatus. In appearance this resembles a torsion balance, one end of the rigid beam carrying the magnetic needle. A light plumb-line rests against the other end of the beam. When the beam has been deflected on the application of the magnetic force it is brought back to its zero position by displacing the point of suspension of the plummet so as to cause the suspension fibre to press lightly against the beam. The small horizontal force so applied is measured by the displacement given to the point of suspension. Various devices for preventing disturbance by air currents, &c., are described. Results are given of eight experiments with various magnets. The values of H so determined do not differ in any case by so much as 2·3 per cent. from the mean and the probable error of the average is only 0·3 per cent. A. D. R.

1755. *Specific Heat of Ferromagnetic Substances: Alloys of Iron and Nickel.* **A. Dumas.** (Archives des Sciences, 27. pp. 352–382, April, and pp. 453–478, May, 1909.)—The author has made measurements of the specific heats of various alloys of Ni and Fe, more especially in the region comprising the point of magnetic transformation [see Weiss and Beck, Abstract No. 1496 (1908)]. The curves expressing the mean specific heat as a function of the temperature all follow similar courses. The specific heat increases at first slowly, then more and more rapidly up to a certain point at which the curve becomes horizontal; this point corresponds exactly with the point of magnetic transformation. Curves connecting the true specific heat with the temperature show that this specific heat at first exhibits increasingly rapid, parabolic augmentation, then a sudden fall to a lower value, and subsequently renewed rapid rise. The absolute value of the discontinuity of the true specific heat at the point where ferromagnetism disappears is proportional to the square of the absolute temperature of this transformation point. The positions of the points of transformation do not obey the law of mixtures, but vary with the content of Ni in an ill-defined manner. Apparently, the other ferromagnetic properties obey a law similar to that determining the positions of the points of transformation. T. H. P.

1756. *Measurement of High Inductions. Certain Physical Properties of Iron-Silicon Alloys.* **E. Gumlich.** (Zeitschr. Elektrochem. 15. pp. 597–599; Discussion, p. 600, Aug. 15, 1909. Paper read at the 16th. Hauptversamml. d. Deutsch. Bunsen-Gesell., May 24, 1909.)—The disadvantages of Ewing's "isthmus" method for measuring high inductions may be avoided: (1) by retaining for the different measurements the same conical pieces of soft iron, only the isthmus-piece being made of the material to be investigated; (2) by arranging the two spools, which occupy the whole of the free space between the conical pieces, on a fixed support. With such an arrangement, and by employing a small du Bois semicircular electromagnet, field strengths of about 5,000 gauss may be obtained, this being sufficient for soft magnetic materials. Results are given of the measurements for a number of different materials, including a series of iron-silicon alloys with increasing Si-content, together with the chemical compositions. In the case of the iron-silicon alloys it is found, excepting for those containing a large proportion of Si (5·4 and 8·3 per cent.), that the saturation value 4πI, diminishes in direct proportion as the percentage of Si present increases, its value being 21,400 for 0 per cent. of Si (cast steel) and 19,100 for 4·5 per cent. of Si. It is hence evident that the improvement often produced in the magnetic properties of cast steel by the addition of silica is of a secondary nature, depending on a diminution or removal of the influence of other harmful impurities. The specific resistance of these silicon alloys increases in direct proportion with the Si-content, being 0·12 ohm per m./mm.^{2} for the cast steel, and 0·70 for the alloy containing 5 per cent. of Si. Within these same limits of Si-content, the temperature-coefficient of resistance diminishes approximately hyperbolically from 0·6 to 0·05 per cent. Possibly owing to the formation of various Si-Fe compounds, the specific resistance and its temperature-coefficient for the alloy containing 8·3 per cent. of Si deviate considerably from the above laws. T. H. P.

1757. *Chemical Constitution and Magnetic Properties of Iron Compounds.* **S. Hilpert.** (Deutsch. Phys. Gesell., Verh. 11. 14. pp. 293–299, July 30, 1909. From the Metallhüttenmänn. Laborat. d. techn. Hochschule, Charlottenburg. Ber. Deut. Chem. Gesell. 42. pp. 2248–2261, 1909.)—From a consideration of the magnetic behaviour of the ferrites, and in particular of copper, cobalt, and iron ferrites, which, whilst being ferromagnetic, can be obtained either amorphous or colloidal, it is evident that crystalline structure is not an essential in a ferromagnetic substance. The same ferrites, and also Cu-Pb ferrites, can also be had in the crystalline state by sintering the correct proportions of the respective oxides together. Despite the feeble magnetism of lead ferrite, the permeability of the complex ferrites appears to be high, although the conductivity falls to 10^{-9} of that of iron. The magnetic change of the magnetic iron oxide upon oxidation is found to occur at 500° (cf. Abstract No. 902 (1909)]. The oxidation of cobaltoferrite into cobaltiferrite is accompanied by an analogous magnetic transition at 280° to 300°. Although not established the author finds that probably remanence is the magnetic property which is most influenced by crystallisation. F. R.

1758. *Influence of Arsenic and Tin upon the Magnetic Properties of Iron.* **C. F. Burgess** and **J. Aston.** (Electrochem. Ind., N.Y. 7. pp. 403–405, Sept., 1909.)—The authors have prepared alloys from electrolytically refined iron (containing 99·97 per cent. Fe) by melting it up with varying proportions of arsenic and tin in magnesia crucibles. Check analyses were made, as there was a considerable loss in the case of the tin compounds. The magnetic tests were carried out on an Esterline permeameter and with the material in four different conditions, viz., (1) as forged into rods, (2) after annealing at 675° C., (3) after annealing at 1,000°, (4) after quenching at 900° in water. The addition of small quantities of As has little effect, but when 3½ to 4 per cent. has been added there is a marked improvement in quality. The permeability is then equal to that of electrolytic iron for $H > 50$, and is superior for lower fields. The area of the hysteresis loop for $B = 12{,}000$ is also reduced to two-fifths by the addition of 3·9 per cent. As. Similarly by adding 2 per cent. Sn to the iron the hysteresis loss for $B = 12{,}000$ is reduced to two-fifths while the corresponding value of H is only increased by about 1 per cent. Also, as in the case of silicon, the addition of As or Sn not only improves the magnetic quality but it increases the electrical resistance with a consequent reduction of eddy-current losses. Should further investigation show ageing qualities comparable to those of silicic iron, these Fe-As and Fe-Sn alloys may be useful in transformer working. A. D. R.

REFERENCES.

1759. *Masses of Moving Electrons.* **E. Hupka.** (Deutsch. Phys. Gesell., Verh. 11. 11. pp. 249–258, June 15, 1909. Physikal. Inst. d. Univ., Berlin.)—An account of an experimental investigation of the relative merits of the two theories of the nature of electrons called by Planck the "Sphere theory" and the "Relative theory." The method depended upon photoelectric action, and the electrons were accelerated by means of an electrostatic field. The result of the inquiry is in favour of the "Relative theory." *Erratum.* (Ibid. 11. 13. p. 290, July 15, 1909.) J. J. S.

1760. *Sparking Potentials between Spherical Electrodes.* **M. Toepler.** (Ann. d. Physik, 29. 1. pp. 153–159, April 22, 1909.)—A criticism of Müller's work [see Abstract No. 881 (1909)]. Tables are given of the results obtained by Müller, Toepler, and others in the case of spherical electrodes. W. C. S. P.

1761. *Use of Zinc Sulphide for the Braun Tube.* **F. Giesel** and **J. Zenneck.** (Phys. Zeitschr. 10. pp. 377–378, June 1, 1909. Physikal. Inst. d. techn. Hochschule, Braunschweig, March 28, 1909.)—Advocates the employment of zinc sulphide for the screen as giving greater brightness and improved definition. L. H. W.

1762. *Thermopiles.* **E. Altenkirch.** (Phys. Zeitschr. 10. pp. 560–568, Aug. 15, 1909.)—A discussion of the conditions on which the useful effect of the thermopile depends. J. J. S.

1763. *Sensitive Speed-regulator for Electric Motors.* **E. Giebe.** (Zeitschr. Instrumentenk. 29. pp. 205–216, July, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)

1764. *The Marine Compass and a New Electromagnetic Compass.* **L. Dunoyer.** (Annal. Chim. Phys. 16. pp. 433–473, April; 17. pp. 5–126, May, and pp. 314–353, July, 1909.)—This comprehensive monograph first treats exhaustively of the theory of the compensation of the marine compass and then passes on to consideration of the author's electromagnetic form of compass [see Abstracts Nos. 1193 (1907), 1164 1908)]. L. H. W.

1765. *Physical Properties of Crystalline Silicon.* **C. I. Zimmerman.** (Amer. Electrochem. Soc., Trans. 15. pp. 395–409, 1909. Elect. Rev. and West. Electn. 54. pp. 977–980, May 29, 1909. Abstract.)—Miscellaneous data collected from various sources. A few experiments on electrical conductivity of rods are mentioned, and an attempt is made to apply a formula to express the results. L. H. W.

1766. *String Electrometer.* **T. H. Laby.** (Cambridge Phil. Soc., Proc. 15. pp. 106–113, May 21, 1909.)—Experiments with an electrometer similar to Wulf's [Abstracts Nos. 1087, 1910 (1907)].

1767. *Quadrant Electrometer for recording Atmospheric Electrical Phenomena.* **H. Ebert.** (Zeitschr. Instrumentenk. 29. pp. 169–178, June, 1909. Physikal. Inst. d. techn. Hochschule, München, Feb., 1909.)—A description of the electrometers in use at Munich for three years as adapted for recording ionisation and dissipation. R. G. K. L.

1768. *A Standard of Wave-length for the Calibration of Cymometers.* **J. A. Fleming.** (Electrician, 63. p. 459, July 2, 1909.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1769. *New Proof of the Actual Existence of Molecules.* **T. Svedberg.** Zeitschr. Phys. Chem. 65. 5. pp. 624–633, Feb. 16, 1909. Chem. Universitätslaborat., Upsala, Jan., 1909.)—Experiments are described on the limit of visibility of the colour produced by various substances in dilute solutions, passing from copper sulphate to fuchsin and colloidal gold. It is shown that in the case of colloidal particles the absorptive power is at first almost independent of the size, but proportional to the number, of the particles. On reducing the size of the particles, however, their absorptive power becomes less and finally the ordinary condition of a transparent (true) solution is attained. The author argues that his experiments demonstrate the continuity of the colloidal and crystalloidal states, and therefore the corporeal existence of molecules. T. M. L.

1770. *Chemistry of the Fundamental Radio-active Substances.* **D. Strömholm** and **T. Svedberg.** (Zeitschr. Anorg. Chem. 63. 3. pp. 197–206, Aug. 16, 1909.)—Of the elements of the actinium series, actinium itself is isomorphous with lanthanum and radio-actinium with thorium, whilst actinium-X is an alkaline earth metal. The authors discuss the quantitative solubility relations between the three radio-active alkaline earth metals, Ra, ThX, and AcX, and the systematic arrangement of the radio-active elements. T. H. P.

1771. *Crystallisation through Membranes.* **J. H. Walton, Jr.** (Journ. Phys. Chem. 13. pp. 490–500, June, 1909.)—The crystallisation of supersaturated sodium sulphate takes place freely through a layer of filter-paper; it is also transmitted through gold-beater's skin, parchment paper, and (less rapidly) through collodion. In the case of undercooled organic liquids crystallisation will often take place through a rubber membrane; in the case of phenol this can be prevented by the addition of a trace of water, but not by diluting with a little benzene. T. M. L.

1772. *Large Electric Furnaces.* **R. Taussig.** (Zeitschr. Elektrochem. 15. pp. 542–544, Aug. 1, 1909.)—The capacity of electric furnaces has been increased by the device of using more than one group of three-phase electrodes. Practical considerations have hitherto simultaneously limited to three the number of groups which can be used in the same furnace, and the power which may be supplied to each group to 2,500 to 3,000 kw. Helfenstein's carbide furnace is in particular considered and described, although similar limitations will apply in furnaces intended for the manufacture of ferro-silicon. The heat of combustion of the gaseous products of the reaction is so great that special protection of the electrical plant and for the workmen is necessary when the power exceeds 3,000 kw. per group; at the same time the gases become a serious nuisance, and the uniform supply of raw material to the furnace becomes a matter of difficulty. F. R.

1773. *Working Limit in Electrical Furnaces due to the "Pinch" Phenomenon.* **C. Hering.** (Amer. Electrochem. Soc., Trans. 15. pp. 255–277; Discussion, pp. 277–278, 1909. Electrochem. Ind., N.Y. 7. pp. 266–267; Discussion, pp. 267–268, June, 1909.)—The purpose of this paper is to analyse the "pinch" phenomenon and to give its laws as far as possible. The phenomenon is not of a simple nature, and a purely mathematical solution cannot be depended on absolutely for calculating actual cases, because such unknown and uncertain quantities as the viscosity, the frictional resistance of a liquid moving at high velocity in a liquid, the changes of density at high temperatures, &c., are involved. In view of these facts the paper is limited to a general analysis of the action with such conclusions as can be deduced from it, and to the development of some approximate formulæ for the more usual cases occurring in practice. The following is the summary of the results obtained: The pinching action applies equally well to direct and to alternating currents. The contracting force is a function of the current and of the size and shape of the cross-section and may be determined from these. It is independent of the voltage, resistance, watts, heat, temperature, length of channel, &c., except in so far as changes in these may effect the other quantities. The opposing force in a horizontal column is a function of the density of the liquid and of the depth of the axis of the contracted column. The actual contraction also involves the viscosity, fluid friction, smoothness of the channel, weight of floating masses, &c. For circular sections the accurate quantitative relations are known [Northrup, Abstract No. 1681 (1907)]. For rectangular sections whose heights are about twice the widths, the critical current can be predetermined with close approximation by the method described in the paper. For departures from these proportions of the section, the same formula is believed to be sufficiently approximate to serve as a general guide. The rupturing phenomenon takes place at only relatively high current-densities. When rupture does occur the result is likely to be a frozen charge or a broken core, probably necessitating a dismantling of the furnace, unless the rupture will heal at once by opening the circuit for a moment and following it by a reduced current. In an appendix to the paper certain experimental results are given bearing on this subject.

C. O. B.

1774. *Furnace Electrode Losses.* I., II., and III. **C. A. Hansen.** (Amer. Electrochem. Soc., Trans. 15. pp. 279–299; Discussion, pp. 299–302, 1909.)—I. Considers the losses of heat in electric furnace electrodes made of carbon and graphite respectively. Experimental results for various furnace runs are given in detail. In the case of one comparison, in which the two electrodes were subject to the same conditions, the maximum electrode losses were 24·8 kw. with carbon electrodes as against 55 kw. with graphite electrodes. In another experiment it was found that by increasing the length of the electrode embedded in the wall, the total electrode loss was not increased although the effective resistance length of electrode and the current density were increased. A further experiment is described in which idle electrodes were also introduced to show comparative heat losses by conduction. Examples are given of methods of approximately determining the temperatures by the physical examination of the electrodes, for example, by the determination of hardness by the Shore sclerescope, absolute density by weighing in benzol, and electrical resistance. The results show that for the particular type of electrode used, namely, the short water-cooled electrode of which the only portion projecting from the furnace is the water-cooled head, carbon electrodes are less wasteful of heat than graphite electrodes of the same cross-section at current densities below 200 amps per sq. in. In furnaces taking 500 kw. the electrode losses may easily reach 15 per cent. of the total load impressed. Under the conditions described the ratio of the heat conductivities of graphite and carbon is about 8 to 1 instead of 18 to 1 (FitzGerald), the ratio being brought down to this figure probably owing to the partial graphitisation of the carbon. In an Appendix, some notes on carbon are given together with curves illustrating the changes in apparent and absolute density, resistance, weight, size and hardness caused by firing carbons made of graphite, petroleum coke and lampblack at temperatures varying from 500° to 3,000°. In the *discussion*, **J. W. Richards** thought that for comparative work the graphite and carbon electrodes should not have been made the same size, but that sizes should have been taken in proportion to the conductivities of the materials. II. (Electrochem. Ind., N.Y. 7. pp. 358–359, Aug., 1909.)—This second paper describes a few experiments made to determine the effect of electrode length on losses of heat. For this purpose furnaces were used with the end walls 4 in., 8¾ in. 13 in., and 15½ in. in thickness. The electrodes passing through these walls, projected 6 in. into the furnace and were water-cooled by jackets attached to the 12-in. length immediately outside the furnace walls. The electrode loss was taken from the cooling water. All comparisons were made with as nearly a constant temperature-difference as possible, this difference being kept high, about 2,500 deg. to 3,000 deg. Tables of results are given from which it is evident that the gain in increasing length of electrode is greatest at currents below 2,000 amps., current density 125 amps. Above this value, the C^2R loss rises rapidly with the current and the gain in efficiency by increasing the wall thickness is lessened. The data given show that the efficiency of a graphite electrode increases rapidly with increasing current density. It is pointed out, however, that the higher the current density, the hotter becomes the electrode embedded in the furnace wall, and a limit is soon reached at which the refractory material of which the furnace is built, melts down. As an example of this, it has been found that at 10,000 amps. an 8 in. × 8 in. graphite electrode and its 13-in. wall will last for 50 or more runs of 10 hours each; at 15,000 amps., with the same apparatus, the wall usually lasts 4 or 5 runs, whilst at 20,000 amps., the same furnace has repeatedly blown out round the electrode after running a few hours. With carbon electrodes it would appear that increasing length of electrode would bring about a decrease of electrode efficiency, for the reason that the C^2R loss is much greater than the heat conduction loss, even in short electrodes. III. (Ibid. pp. 389–391, Sept., 1909.)—This third paper contains results of tests on the comparative oxidation rates of carbon and graphite. The rods to be examined were heated by an electric current to temperatures varying from 925° to 1,305° C. as indicated by a Wanner pyrometer, for 15 min. The rods were dried, weighed, and accurately measured before the test, and afterwards were brushed lightly, weighed, and again measured. In only one case did the graphite rod lose less than the carbon rod; but in spite of this the results do not show that graphite is more readily oxidised than amorphous carbon, for, when a graphite rod is heated to 1,300° to 1,400° it throws off particles of graphite, many of which are so large that they are not completely burned when they leave the rod, but can be collected on a sheet of asbestos held underneath it. None of this loss was noted with the carbon samples heated. The probable explanation is the greater porosity of the graphite, which enables the binder carbon to be oxidised, the originally bound particles falling away when this takes place. To show that the falling off of the particles was due to oxidation, a rod which showed a decided tendency to flake off was heated in CO to a temperature above 2,000°, in which case there was practically no loss. It is fairly certain that in ordinary furnace use, graphite electrodes are not inherently superior to carbon electrodes on the score of resisting oxidation. As soon as the electrodes become pointed by oxidation, the power consumption increases: the difference between a full square end and a point end on an electrode makes a power consumption difference of fully 30 per cent. Experiments have been tried to reduce electrode oxidation by coating with a paste of carborundum and water glass, but no convenient way of making the paste stick uniformly has yet been found. The results are in favour of properly made carbon electrodes for use in steel furnaces, &c. C. O. B.

1775. *Hardness and Microstructure of Cadmium-Zinc Alloys.* **A. V. Schaposchnikoff** and **M. Sacharov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. pp. 907–914, 1907.)—Cadmium and zinc give no definite compounds and no solid solution, except possibly at 98–95 per cent. of zinc. At the composition 17·6 per cent. Zn, a eutectic mixture is formed when the hardness of the alloy reaches a relative maximum, after which the hardness and resistance falls, until at the composition 80 per cent. Zn there is a sudden rise to an absolute maximum. At this point the alloy is more homogeneous than at any other composition. L. H. W.

1776. *Hardness and Microstructure of Lead-Antimony Alloys.* **A. V. Schaposchnikoff** and **I. Kanewskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. pp. 901–907, 1907.)—As antimony is added to lead, the hardness and the resistance to pressure of the alloy increases. At the eutectic point (13 per cent. of Sb), the alloy is most homogeneous, and its hardness and resistance is greater than any of the other neighbouring alloys. The hardness of alloys containing more than 30 per cent. Sb depends mainly on the presence of crystals of Sb in the eutectic mixture. The two metals form no definite compounds but solid solutions may possibly exist. The alloys investigated had an Sb content ranging from 12 to 90 per cent. L. H. W.

1777. *Cooling of Binary Alloys of Tin with Lead, Zinc, and Bismuth.* **D. Mazzotto.** (Accad. Sci. Modena, Mem. 9. Ser. 3. pp. 3–8, 1909.)—The author confirms his original statement, disputed by Stoffel [Abstract No. 908 (1907)], that at about 150° C. there is a critical point in the cooling of Pb-Sn alloys, this reaching a maximum for alloys containing 33–43 per cent. Sn. Similar critical points are observed with Sn-Zn and Sn-Bi alloys, that with the latter occurring at 95°. The phenomenon is probably connected with the changes in metallic Sn at 170° and 18°. [See also Abstracts Nos. 322 and 727 (1909).] W. H. Sı.

1778. *Alloys of Copper and Magnesium.* **G. Urazov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. pp. 1566–1581, 1908. Chem. Centralblatt, 1. p. 1038, 1908. Abstract.)—The results of the thermometric examination of alloys of Cu and Mg were as follows:—

Atoms of copper per cent.	0	1·67	6·4	14·48	16·0	17·0	29·4	33·3	33·66
Solidification temperature	650°	634°	580°	500°	B	494°	566°	570°	569°
Eutectic temperature	A	478°	480°	480°	480°	480°	480°	C	552°

Atoms of copper per cent.	37·8	40·45	41·5	42·58	45·1	50·37	60·0	65·4	66·6
Solidification temperature	564°	557°	D	600°	661°	721°	787°	798°	799°
Eutectic temperature	554°	555°	555°	555°	554°	554°	554°	554°	E

Atoms of copper per cent.	66·93	70·0	73·0	77·5	78·0	79·8	85·7	90·0	100
Solidification temperature	797°	786°	765°	728°	F	748°	861°	948°	1,084°
Eutectic temperature	723°	725°	725°	725°	725°	725°	725°	725°	G

The cooling curve constructed from these results shows three eutectic points, B, D and F, and two distectic points, C and E, which latter correspond to the melting-points of the compounds, Mg_2Cu and $MgCu_2$, respectively. No solid solutions are formed either of the two metals or of the metals and the compounds mentioned. These results are confirmed by the microstructure of the alloys. No evidence was obtained of the existence of the compound, MgCu, mentioned by Boudouard; also the melting-point of the compound, $MgCu_2$, is 799° C., not 915° C., as given by Boudouard.

L. H. W.

1779. *Hardness of Lead-Tin Alloys.* **A. Schaposchnikoff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. pp. 92–95, 1908. Chem. Centralblatt, 1. p. 1450, 1908. Abstract.)—Alloys of lead and tin, the cooling curve of which, according to Roberts-Austen, consists of two branches intersecting at the eutectic point (88 per cent. Pb), were examined with respect to hardness by Brinell's method. The results were as follows, the degree of hardness being expressed in kg. per mm.^{2}:—

Tin, per cent. ...	0	10	20	30	40	50	60	66	67	68	70	80	90	100
Solidification temperature	316°	295°	272°	253°	235°	213°	183°	180°	180°	178°	180°	198°	215°	229°
Degree of hardness	3·90	10·10	12·16	14·46	15·76	14·90	14·58	16·66	15·4	14·58	15·84	15·20	13·25	4·14

The results indicate that the max. degree of hardness is found in the case of the eutectic alloy.

L. H. W.

1780. *Hardness of Aluminium-Zinc Alloys.* **A. Schaposchnikoff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. pp. 95–100, 1908. Chem. Centralblatt, 1. pp. 1450–1451, 1908.)—According to Heycock and Neville, the cooling curve of the Al-Zn alloys consists of two branches intersecting at the eutectic point (4·9 per cent. Al). Shepherd states that in addition to the eutectic, there are also formed two series of mixed crystals containing up to 50 per cent. of Zn and up to 2 per cent. of Al respectively. The author determined the hardness (kg. per mm.^{2}) and elasticity (kg. per cm.^{2}) of these alloys, with the following results:—

Zinc, per cent.	0	10	15	20	30	40	60	70	80	90	94	95	96	98	100
Hardness	25·4	47·8	66·0	89·0	107·0	85·0	67·0	64·3	57·0	73·3	74·0	77·9	73·0	72	36·7
Elasticity	402	985	—	1840	2530	1900	2140	2230	1670	1670	1425	1290	1185	1210	570

The eutectic alloy thus shows a relative maximum degree of hardness, whilst the alloy containing 70 per cent. of Al shows an absolute maximum degree of hardness and of elasticity, which the author attributes to the formation of mixed crystals.

L. H. W.

1781. *Gold-Magnesium Alloys.* **R. Vogel.** (Zeitschr. Anorg. Chem. 63. 3. pp. 169–188, Aug. 16, 1909.)—Gold and magnesium combine with explosive violence at 800° C., especially in the proportions necessary to form $AuMg_3$. The alloys were made by slowly adding gold in small pieces to molten Mg in an atmosphere of hydrogen, and examined by the method of thermal analysis, the results being confirmed and extended by microscopic examination of both slowly cooled and quenched alloys. The equilibrium diagram shows three maxima, at 1,160°, 796°, and 860° C., corresponding, respectively to the separation of the compounds AuMg, $AuMg_2$, and $AuMg_3$. The Au-AuMg eutectic contains 28 atoms per cent. Mg and solidifies at 832° C.; the AuMg-$AuMg_2$ eutectic contains 64·7 atoms per cent. Mg and solidifies at 774° C.; the $AuMg_2$-$AuMg_3$ eutectic contains 70 atoms per cent.

Mg and solidifies at 774° C., while the $AuMg_3$-Mg eutectic contains 91 atoms per cent. Mg and solidifies at 576° C. At the gold end of the series solid solutions containing up to 18 atoms per cent. Mg are deposited, and all the compounds separate as solid solutions except in the case of $AuMg_3$ and Mg, which appear to be mutually insoluble in the solid. The $AuMg_2$-$AuMg_3$ alloys undergo a thermal change at 718° C., owing to the reaction: solid solution $\rightleftarrows AuMg_2 + AuMg_3$ taking place. All the alloys are stable in the atmosphere with the exception of those containing free Mg, which are only slowly attacked in a damp atmosphere.

F. C. A. H. L.

1782. *Lead-Tin Alloys.* **P. N. Degens.** (Zeitschr. Anorg. Chem. 68. 3. pp. 207–224, Aug. 16, 1909.)—The work of most of the previous workers is briefly reviewed, the author being of the opinion that there is still some doubt as to the range of existence of solid solutions. Alloys were made and examined by thermal, dilatometric, and metallographic methods. Thermal analysis shows that the two metals are mutually, completely soluble in the liquid, there being no compounds deposited. The two branches of the liquidus cut at a temperature of 181° C. and a concentration of 24·4 atoms per cent. Pb, but on the lead side of the series, the eutectic temperature appears to be somewhat low on account of supercooling. Tin is soluble in lead in the solid to the extent of 12 atoms per cent., but tin will only dissolve about 0·21 atom per cent. Pb. A thermal change takes place at 146° C., and is of max. duration at 57 atoms per cent. Pb, corresponding to the formation of the compound Pb_4Sn_3. The temperature of this change falls rapidly at the Pb end of the series. Cooling-curves of large masses of pure lead failed to show any thermal change taking place in the solid, but the curves of pure tin indicate a change taking place at 160–164° C. Dilatometric experiments in an air dilatometer confirm the results of the thermal method and show clearly the change at 146° C. Pure tin shows a decided volume-change at 161° C. Microscopic examination of a slowly cooled alloy containing 55·8 atoms per cent. Pb shows the existence of white spots in the dark primary Pb crystals, while in the alloy quenched from 170° C. the primary Pb crystals are quite homogeneous. The author ascribes these white dots to the decomposition of the solid solution resulting in the formation of Pb_4Sn_3.

F. C. A. H. L.

1783. *Cementation of Iron.* **L. Guillet** and **C. Griffiths.** (Comptes Rendus, 149. pp. 125–127, July 12, 1909.)—Upon heating low-carbon steel with sugar carbon *in vacuo*, an appreciable cementation occurred very slowly. When both steel and carbon had first been heated *in vacuo* separately and then cooled, before finally heating together, at 1,000° for 5 hours *in vacuo*, no cementation whatever could be detected, unless the carbon and steel were pressed into contact by means of screw pressure, in which case cementation proceeded very slowly. It is concluded that carburisation by pure carbon plays no more than an insignificant part in industrial cementation. F. R.

1784. *Treatment and Solubility of Steel in Sulphuric Acid.* **E. Heyn** and **O. Bauer.** (Iron and Steel Inst., Journ. 79. pp. 109–226; Discussion and Correspondence, pp. 227–241, 1909. Königl. Materialprüfungsamt, Mitt. 27. 2 and 3. pp. 57–132, 1909. Metallurgie, 6. pp. 475–486, Aug. 8, 1909.)—As already observed [see Abstract No. 1488 (1906)], the solubility of quenched steels in 10 per cent. sulphuric acid has a max. value after tempering at 400° C. A one per cent. carbon steel quenched in cold water from 900° and reheated to 400° is said to consist of pure osmondite. Troosite is re-defined as intermediate between martensite and osmondite; sorbite as intermediate between osmondite and pearlite. For the determination of the relative temper of a hardened tool-steel, the comparative solubility test in dilute sulphuric acid can be employed, together with the scratch hardness test, the colour given upon etching with alcoholic hydrochloric acid, and eventually quantities of "free" "carbide" and "hardening" carbon. The max. solubility of a 0·07 per cent. carbon steel quenched from 1,000° also occurred after reheating to 300°–400°. The solubility of 1 per cent. carbon steel is but little dependent upon quenching temperature if above the critical range. The increase of solubility of structural steel in sulphuric acid caused by cold-working is perceptible when the deformation is as little as 2 per cent. Other metals do not all behave in the same manner. Small variations in composition of either metal or acid affect the rate of solution materially. Some specific gravity observations are given. F. R.

1785. *Preservation of Iron and Steel.* **A. S. Cushman.** (Iron and Steel Inst., Journ. 79. pp. 33–68; Discussion, pp. 93–108, 1909. Engineering, 87. pp. 710–713, May 21, and pp. 742–744, May 28, 1909.)—In cases where the use of a protective coating or a passive surface on iron is impracticable, the author considers that highly pure iron should be used when resistance to corrosion is essential. It is stated that iron containing carbon 0·026, sulphur 0·019, and phosphorus 0·004 per cent. is being manufactured in America. The use of an acid flux in galvanising is objected to, as it is liable to lead to corrosion. A. H. Gardner and the author prefer zinc oxide in an alkaline solution. Certain Zn-Fe alloys are electro-negative to iron, and if formed in galvanising they favour corrosion. Tests are in progress in which fences made of galvanised steel wire of known history are exposed to the weather. Pigments are divided into inhibitors and stimulators of corrosion, and indeterminate, as a result of tests in which the loss of weight of a piece of iron in a mixture of water and pigment, through which air was bubbled, was measured. The inhibitors are zinc lead chromate, zinc oxide, zinc chromate, zinc barium chromate, zinc lead white, inhibitive Prussian blue, chrome green (blue tone), white lead (Dutch process), ultramarine blue, willow charcoal. The details of manufacture of the pigments, however, have a bearing upon the inhibitive value of a pigment. It is undesirable from the point of view of the electrolytic theory of corrosion that the first coat of paint should contain any constituent of good conductivity, as, *e.g.*, lampblack. A rough test of the relative protective behaviour of pigments consists in making them up into water-paints, coating on clean steel, *e.g.*, knife-blades, and leaving in contact with wet blotting-paper. The paint is washed off after a few weeks, and the state of the steel surface indicates the degree of protection afforded. The results usually agree with those given by the Thompson test. Service tests of paints are being carried out on a considerable scale. Painted steel plates are undergoing exposure upon the sea-shore. The author states that a lacquer consisting of chromic acid crystals slowly added to a filtered alcoholic solution of shellac prohibits corrosion. [See also Abstract No. 1828 (1908).] F. R.

1786. *Solvent Action of Pure Distilled Water on Metals.* II. **M. Traube-Mengarini** and **A. Scala.** (Accad. Lincei, Atti, 18. pp. 111–116, Aug. 15, 1909.)—Repeated evaporation of pure distilled water in a silver vessel has produced a solution containing 0·0162 gm. Ag per 100 c.cm. The solvent action of pure water on platinum [see Abstract No. 1467 (1909)] is confirmed, but the quantity dissolved is too small for estimation. The conductivity of the purest distilled water may probably be due to this solvent action, 200 c.cm. of distilled water, possessing originally a conductivity of 0·00000518, on concentration to 100 c.cm. in vessels of Pt, Ag, and porcelain, having conductivities of 0·00001640, 0·0000363, and 0·00004180 respectively. When several plates of lead are immersed successively in the water of Mangiatorella, no solution takes place, even after six days, so that the insolubility of Pb in such water must be attributed not only to the presence of bicarbonates of the alkaline earths in solution, but to other unknown factors.

W. H. St.

1787. *Retarding Effect of Oxygen on the Rate of Interaction of Chlorine and Hydrogen.* **D. L. Chapman** and **P. S. MacMahon.** (Chem. Soc., Journ. 95. pp. 959–964, May, 1909.)—The authors find that when a moist mixture of chlorine and hydrogen containing a known amount of oxygen is exposed to light of constant intensity, the rate of formation of HCl is, to a first approximation, inversely proportional to the amount of oxygen present. It is concluded from this result that the sensitiveness of a mixture of chlorine and hydrogen from which all oxygen has been removed would be infinite. The above quantitative relation is shown to be in harmony with the theory of inhibition advanced by Burgess and Chapman [Abstract No. 948 (1907)].

T. H. P.

1788. *Solid State.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 765–780, April 22, 1909.)—The author deals with peculiarities in the isotherms previously studied [see Abstract No. 1150 (1909)]. These isotherms, after having risen to comparatively high pressures when the value of v becomes about equal to that of b in van der Waals' equation, bend back again into the region of low pressures, subsequently ascending rapidly to the highest pressures. Mathematical explanation of this phenomenon is given.

T. H. P.

1789. *Solid State* II. **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 26–42, June 25, 1909.)—Further development of the considerations concerning van der Waals' equation of state previously treated of [see preceding Abstract] indicates the existence, under certain conditions, of a "triple point" for a simple substance. The third phase thus indicated can hardly be other than the solid phase known for nearly all simple substances. Below the triple-point temperature it can be in equilibrium either with the vapour or with the liquid (for high pressures, if Δb is negative); only at the triple-point can it be in equilibrium with both vapour and liquid. For a simple substance, the molecules of which can combine to larger complexes, and where Δb differs from zero, the following possibilities thus exist: (1) A phase with large specific volume—the gaseous; (2) a phase with small specific volume, but internally still sufficiently mobile in consequence of comparatively slight complex-formation—the liquid; and (3) a phase, also with small specific volume, but internally immobile in consequence of extensive complex-formation—the solid phase. The subject is treated mathematically.

T. H. P.

1790. *Catalysis by Moisture.* **J. Meynier.** (Comptes Rendus, 148. pp. 1516–1517, June 7, 1909.)—The author has investigated the interaction of nitric oxide and oxygen in order to ascertain in what condition the necessary small proportion of water must be present for combination of the gases to occur. Neither drying of the gases nor filtration through cotton-wool, nor both these processes together, has any influence on the reaction or on its speed. So that the small drops of water having diameters of the order of 0·01 micron, known as large ions, are not necessary for this reaction, which is determined by actual water-vapour. The velocity of the reaction is not proportional to the quantity of water-vapour introduced. T. H. P.

1791. *Absorption.* Part X. *Properties of Hydrogels in Dehydration and Rehydration.* **J. M. van Bemmelen.** (Zeitschr. Anorg. Chem. 62. 1. pp. 1–23, March 11, 1909.)—The following classification is advanced: (1) *True solutions* are liquids consisting of one phase and homogeneous. (2) A *sol* is heterogeneous and consists of two liquid phases: it is opalescent and shows Tyndall's phenomena. (3) A *gel* is more markedly heterogeneous than a *sol*, and results from the separation of a micellar mesh-work in a *sol;* the two phases are therefore more widely separated and the opalescence is more pronounced, though the *gel* may still be transparent. The dehydration of a *hydrogel* shows two striking features: (1) the appearance and disappearance of a turbidity in the mesh-work of the *gel*, and (2) the appearance of minute hollows in the mesh-work, both changes occurring at definite stages in the dehydration. The water is held in the *gel* by physical and not by chemical force, as is shown by the fact that there are no abrupt changes in the vapour pressure or in the velocity of dehydration; there are, however, three stages in the dehydration—a rapid loss of water at an almost uniform rate, followed by a steady decrease of velocity, and finally by an almost complete arrest. Other points which are dealt with may be referred to in the original paper. T. M. L.

1792. *Determination of Solubility by means of Pulfrich's Refractometer.* **Y. Osaka.** (Coll. Sci. and Engin., Mem. Kyōtō, 1. 4. pp. 290–303, 1908.)—The author has tested more thoroughly the method described previously [Abstract No. 173 (1908)], his investigations showing that reliable results may be obtained by this method, provided the solubility is not too small. The formula $ax + bx^2 = \Delta$ holds over a tolerably wide range of concentrations. The constants in the formula are different at different temperatures, but one and the same formula, determined for a particular temperature, may be used in solubility determinations at other temperatures with some modification of the experimental method. The formula may be applied to cases in which a solution is used as solvent, and is equally applicable to those cases in which a chemical reaction takes place between solvent and solute. The method may be carried out accurately with small quantities of solvent and solute. T. H. P.

1793. *Solubility of Lead Sulphate.* **J. Sehnal.** (Comptes Rendus, 148. pp. 1394–1396, May 24, 1909.)—The solubility of lead sulphate in water is the same, namely, 0·0824 gm. per 1,000 c.cm., at 100° as at the ordinary temperature, but saturation is reached more rapidly in the warm. The solubility is influenced by the purity of the lead sulphate, a trace of sulphuric acid considerably diminishing the amount dissolved. The dissolution of lead sulphate in water is a result of the hydrolysis of the salt according to the equation $PbSO_4 + 2H_2O = H_2SO_4 + PbO, H_2O$. T. H. P.

1794. *Birotation of Dextrose.* II. **Y. Osaka.** (Coll. Sci. and Engin., Mem. Kyōtō, 1. 4. pp. 304–319, 1908.)—The influence of change of temperature on the velocity with which the rotating power of dextrose takes place is in good agreement with Arrhenius' formula. With dilutions (v) less than 10 litres per mol. of the salt, sodium chloride retards the velocity of the change; in the presence of hydrochloric acid ($v = 15$), the salt augments the catalytic action of the hydrogen ions, but exerts no action when $v = 10$. The catalytic action of a weak acid may be negative, the velocity being less than in pure aqueous solutions. [See also Abstract No. 676 (1901).]

T. H. P.

1795. *Chemical and Magnetic Study of Complex Compounds.* **P. Pascal.** (Annal. Chim. Phys. 16. pp. 520–574, April, 1909.)—Pyrophosphates and metaphosphates of the metals of the iron family dissolved in solutions of the corresponding alkali salts give salts having compositions similar to those of the complex cyanides, the CN groups of the latter being replaced by $(P_2O_7)^{1/4}$ or (PO_3). Study of the magnetic properties of the salts of iron, complex or otherwise, shows that the disappearance of the chemical properties of the metal is accompanied by disappearance of the magnetic properties. This observation is general to all the complex salts and even to the colloids, and shows that the magnetic properties are not attached to the atom, but to the grouping in which the element considered figures. The magnetic field may hence serve as a reagent for complex compounds, just as the rotation of the plane of polarisation characterises the asymmetric carbon atom. In many cases magnetic analysis affords a simple method of following a slow reaction such as a hydrolysis, and even allows of the existence of new complex compounds being foreseen.

T. H. P.

1796. *Rectilinear Diameter of Acetylene.* **E. Mathias.** (Comptes Rendus, 148. pp. 1102–1105, April 26, 1909.)—If the law of corresponding states for the density curve is applicable to all compounds, the expression $a = -a\Theta/\Delta$—where a is the angular coefficient of the rectilinear diam., Θ the absolute critical temperature, and Δ the critical density—should be an absolute constant. The author has now examined acetylene, to see whether this relation is influenced appreciably by the triple linking. The value of a is found to be 0·8605 and that of $b = a/\Theta$ 0·0489, whilst the corresponding values for CO_2 are 0·858 and 0·0493 respectively. These numbers confirm the observation that the preponderating influence affecting these relations is that of the critical temperature, which is nearly the same for these two gases.

T. H. P.

1797. *Specific Velocity of Ions in Liquid Dielectrics.* **C. Böhm-Wendt** and **E. v. Schweidler.** (Phys. Zeitschr. 10. pp. 379–382, June 1, 1909. Physikal. Inst., Wien, April, 1909.)—The authors have determined the values of the velocity of the ions formed in petroleum ether and vaselin under the influence of radium radiations. The value of $(u + v)$ in the case of the former is $0{\cdot}38 \times 10^{-3} \frac{\text{cm.}}{\text{sec.}} \Big/ \frac{\text{volt}}{\text{cm.}}$, and of the latter $5{\cdot}3 \times 10^{-6} \frac{\text{cm.}}{\text{sec.}} \Big/ \frac{\text{volt}}{\text{cm.}}$. The former value is of the same order as in the case of ions of electrolytes in water.

A. F.

1798. *Freezing-point Curves for Mixtures of Condensed Gases.* **G. Baume.** (Comptes Rendus, 148. pp. 1322–1324, May 17, 1909.)—The gases were condensed by means of liquid air, and the temperatures were measured by means of a thermometer or a thermo-couple: instead of weighing the gases they were passed into the condensation tube from reservoirs of known volume, and the quantities used were deduced from the decrease of pressure in the reservoirs. Curves were plotted for (*a*), $(CH_3)_2O$ and HCl, giving two maxima at −94° (composition C_2H_6O, HCl) and at −102° (composition C_2H_6O, 4HCl); (*b*), $(CH_3)_2O$ and SO_2, giving a maximum at the composition C_2H_6O, SO_2; (*c*), $(CH_3)_2O$ and CH_3Cl giving a similar maximum for which, however, no details are supplied. T. M. L.

1799. *Nature of Ammoniacal Copper Solutions.* II. *Solubility of Cupric Hydroxide in Ammoniacal Sulphate Solutions.* **H. M. Dawson.** (Chem. Soc., Journ. 95. pp. 870–881, March, 1909.)—A study of the distribution of ammonia between chloroform and ammoniacal copper sulphate solutions has indicated that the copper is present in the form of a complex radical $Cu4NH_3$, which is dissociated on dilution or removal of ammonia, with precipitation ultimately of cupric hydroxide. In the present paper further information was sought by studying the reverse process of dissolving cupric hydroxide to saturation in ammoniacal ammonium sulphate solutions. The crystalline copper hydroxide prepared by Böttger's method was found to give a very definite solubility in normal aqueous ammonia (0·0108, 109, 110, 109, 108), and was not altered by keeping for a year. The copper hydroxide dissolved to the extent of 0·5615 molecular proportions per litre at 18° in presence of 5 mols. ammonia and 0·4 mol. ammonium sulphate, lower solubilities being obtained on reducing either of these concentrations: on reducing the ammonia concentrations, whilst retaining a fair proportion of ammonium sulphate, fictitious solubilities were obtained owing to the formation of basic copper sulphate; the ammonium sulphate has apparently no direct solvent action on the copper hydroxide. The conclusion is drawn that the complex $Cu2NH_3$, which might be formed by direct interaction of copper hydroxide and ammonium sulphate, is not formed to any appreciable extent in the liquid, and that the main product is the $Cu4NH_3$ complex, which requires free ammonia for its production. T. M. L.

1800. *Rôle of Contact-electricity in the Permeability of Membranes to Electrolytes.* **P. Girard.** (Comptes Rendus, 148. pp. 1047–1050, April 19, 1909.)—The interposition of a well-washed membrane into a concentration cell formed by two solutions of a neutral salt does not affect the voltage, but this is lowered if an excess of acid or base was originally present: the presence of polyvalent anions in acid cells or of polyvalent kathions in basic cells also reduces the e.m.f. These effects are attributed to contact-forces, which are regarded as important factors in determining the velocity of diffusion through a membrane. In confirmation of this view it is pointed out that the acids and bases which diffuse more rapidly than neutral salts in pure water diffuse more slowly when a membrane is interposed. T. M. L.

1801. *Physico-chemical Properties of the Colloidal Particles called "Micellæ."* **G. Malfitano.** (Comptes Rendus, 148. pp. 1045–1047, April 19, 1909.)—These colloidal particles, which are present, for example, in ferric chloride solutions, can be filtered off by means of a collodion membrane. By determining the properties of the solution before and after filtration it is possible to find to what extent the properties are due to the colloid and to the soluble material in the solution. From experiments carried out in this way the conclusion is drawn that the colloidal particles have a small conductivity, and produce a small osmotic pressure, though this does not obey Boyle's law. The colloidal particles are regarded as made up of insoluble molecules associated with one molecule of electrolyte to form complex ions.

T. M. L.

1802. *Chemical Composition of Colloidal Silver prepared Electrically.* **G. Rebière.** (Comptes Rendus, 148. pp. 854–857, Feb. 8, 1909.)—By measuring the electrical conductivity of electrically prepared [according to Bredig's method] colloidal solutions of silver both before and after precipitating the colloid by addition of a trace of barium nitrate, the author found that the conductivity depends not on the colloidal precipitable silver, but on some form of dissolved intergranular silver (probably present as silver oxide) produced at the same time as the colloidal silver.

D. H. J.

1803. *"Dynamic" Osmotic Pressures.* **Berkeley and E. G. J. Hartley.** (Roy. Soc., Proc. Ser. A. 82. pp. 271–276, May 26, 1909.)—The rate at which water was driven through a copper ferrocyanide membrane was measured for different hydrostatic pressures and compared with the (initial) rates at which water was sucked through the same tube by the osmotic pressure of a well-stirred sugar solution. The close proportionality between osmotic pressure and rate of flow is shown in the first table—

Pressure.	Rate.	Ratio of Rates.	Ratio of Pressures.
atmos.	mm./sec.		
20·41	0·1075	1·	1
40·82	0·2203	2·05	2
61·24	0·3240	3·01	3
81·65	0·4303	4·00	4
102·06	0·5319	4·95	5
122·47	0·6378	5·93	6

whilst the second table—

Concentration.	Rates.	Rates/0·00528 = Dynamic Osmotic Pressure.	Equilibrium Osmotic Pressure.
gm.	mm./sec.	atmos.	atmos.
750	0·571	108·2	134·7
660	0·472	89·5	100·8
540	0·315	59·7	67·5
300	0·134	25·4	26·8
96·2	0·0341	6·46	6·36
45	0·0155	2·94	2·97

shows for the lower concentrations a remarkable agreement between the equilibrium osmotic pressures directly measured and the values deduced from the rates at which water was sucked through the membrane into the solution. In the case of a second membrane-tube a remarkable agreement was found at concentrations right down to 2 gm. per litre, and it is suggested that the dynamic method of measuring osmotic pressures may, in the case of weak solutions, be preferable to the direct or statical method of measurement.

T. M. L.

1304. *Osmotic Pressure of Calcium Ferrocyanide Solutions.* II. *Weak Solutions.* **Berkeley, E. G. J. Hartley** and **J. Stephenson.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 319–336, May 26, 1909.)—Accurate measurements are described of the density, conductivity, and osmotic pressures (up to 25 atmos.) of calcium ferrocyanide solutions, with comparative values for potassium and strontium ferrocyanides. At the lower concentrations the calcium salt produced osmotic pressures agreeing closely with those calculated from the gas laws; the potassium salt gave higher values, whilst the strontium salt gave values lower than those calculated. As all the solutions were electrolytes, the conclusion was drawn that the calcium and strontium salts are polymerised as well as dissociated, the two effects exactly balancing in the case of the calcium salt, but the polymerisation being dominant in the strontium salt at concentrations from 6 per cent. upwards: in the case of the potassium salt the osmotic pressures at the lowest concentrations indicated a dissociation into at least three ions. T. M. L.

1305. *Conductivity and Viscosity in Mixed Solvents containing Glycerol.* **M. R. Schmidt** and **H. C. Jones.** (Amer. Chem. Journ. 42. pp. 37–95, July, 1909.)—Binary mixtures of glycerol with water, methyl or ethyl alcohol deviate widely in their properties from the simple additive law: this is found to be true for the fluidity and for the conductivities of lithium bromide, caesium chloride, and potassium iodide in these mixtures. The temperature coefficients of conductivity in pure glycerol are very large, and are nearly identical with the temperature-coefficients of fluidity. But this proportionality does not appear on comparing the conductivities and fluidities in different solvents of the series methyl alcohol, glycol, and glycerol; in this series the conductivities increase more rapidly than the fluidities. A similar observation has been made by Green in the case of lithium chloride dissolved in water containing various quantities of sugar. T. M. L.

1306. *Molecular Condition of Salts dissolved in a Fused Salt.* II. *Electrical Conductivity of Salts in Fused Mercuric Chloride.* **H. W. Foote** and **N. A. Martin.** (Amer. Chem. Journ. 41. pp. 451–457, June, 1909. Contribution from the Sheffield Lab. of Yale Univ.)—The following values were found for the molecular conductivity of alkali chlorides and cuprous chloride in fused mercuric chloride at 282°:—

V (litres).	CsCl.	KCl.	NH_4Cl.	NaCl.	CuCl.
2	—	81·0	—	61·5	70·0
4	—	66·5	70·0	47·0	46·0
5	70·0	62·0	64·5	43·0	42·0
8	60·5	54·0	55·2	34·0	34·0
10	57·0	50·5	52·0	31·3	31·2
15	51·0	45·7	46·5	28·0	26·0
20	48·5	43·4	—	—	24·0
25	46·5	40·8	—	—	—
30	44·0	38·5	—	—	—

As the freezing-point depressions were normal it was concluded that the ionisation proceeded according to equations such as—

$$2NaCl + HgCl_2 \longrightarrow Na_2HgCl_4 \rightleftarrows \overset{+}{Na} + \overset{-}{NaHgCl_4}$$

and that ionisation in this sense was practically complete. The fact that the molecular conductivity increases with the dilution without any change in the molecular depression of the freezing-point is attributed to the production and dissociation of a more complex salt such as—

$$\mathrm{M_3HgCl_5} \rightleftharpoons \overset{+}{\mathrm{M}} + \overset{+}{\mathrm{M}} + \overset{-\,-}{\mathrm{MCl}}_5,$$

but might equally well have been attributed to the association of the anion $\mathrm{M\overset{-}{H}gCl_4}$ with a further quantity of solvent, comparable with the hydrated ions of aqueous solutions. It is noteworthy that the divalent chlorides (*e.g.*, $\mathrm{BaCl_2}$) which cannot dissociate according to the scheme—

$$\mathrm{M_2HgCl_4} \rightleftharpoons \mathrm{M} + \mathrm{M\overset{-}{H}gCl_4}$$

are insoluble in mercuric chloride, with the exception of cupric chloride, which dissolved but did not increase the conductivity of the mercuric chloride. T. M. L.

1807. *Velocity of Dissolution of Gases in Water.* **W. A. Roth.** (Zeitschr. Elektrochem. 15. pp. 328–331, May 15, 1909.)—Measurements were made of the velocity of dissolution of oxygen, $\mathrm{CO_2}$, and $\mathrm{N_2O}$ in water. In order to secure definite conditions, the water was saturated with hydrogen (thus displacing all other gases), and the course of the dissolution was followed by measurements of freezing-point, the maximum depression produced by hydrogen being only 0·002° C. Converse experiments were also made on the displacement of these gases from solution by means of hydrogen. In each case the action was found to obey a unimolecular law, and to be expressed with considerable accuracy by means of a logarithmic formula, the value of the constant increasing with the intensity of the gas-stream. [Compare J. Meyer, Abstract No. 1827 (1909).] T. M. L.

1808. *Relation between Density and Degree of Dissociation of Aqueous Solutions.* **S. Terešin.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. 4. pp. 155–160 (Phys. Part), 1909. Deutsch. Phys. Gesell., Verh. 11. 9. pp. 211–214, May 15, 1909.)—It has been shown by Heydweiller [Abstract No. 942 (1909)] that, for a large number of salts, the excess, $s-1$, of the density of the solution over that of water at the same temperature may be calculated by means of the formula: $(s-1)/m = A_s i + B_s(1-i)$, where m represents the number of gm.-mols. per litre, i the degree of dissociation, and A_s and B_s constants independent of the concentration. For Heydweiller's two constants, A_s and B_s, the author derives the equations—

$$A_s = N(\mu' - \mu'_0)1000m + N(\mu'' - \mu''_0)/1000m \quad \text{and} \quad B_s = N(\mu - \mu_0)/1000m,$$

in which N represents the number of gm.-mols. of a binary electrolyte per litre, μ_0 the mass of the solvent in the volume of the spheres of action of the molecules, and μ the mass of all the molecules with the mass of the layers of solvent of changing density surrounding them; μ_0' and μ' represent the corresponding magnitudes for one ion, and μ_0'' and μ'' for the other. The values of A_s and B_s calculated in this way for a large number of salts are in good agreement with the experimental values. T. H. P.

1809. *Dissociation of Calcium Carbonate.* **D. Zavrieff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. pp. 34–56, 1909.)—Further experiments on this reaction show that within the limits of temperature 700–950° no intermediate phase is formed, as might have been expected from Raoult's experiments [Comptes Rendus, 92. p. 1457, 1881], and from the fact that the reaction is completely reversible within these limits. At low temperatures the reaction proceeds slowly, the velocity depending greatly on the condition of the surface of the lime, so that accurate investigation is impossible. It cannot be stated with certainty that intermediate products are not formed at 500–600°, at which temperatures, also, solid solutions may be formed. With a considerable excess of lime, when presumably solid solutions with a small content of carbon dioxide are formed, the dissociation pressure is very much less than when calcium carbonate alone is used. T. H. P.

1810. *Dissociation of Hydrated Sulphuric Acid and of Nitrogen Dioxide.* **M. Bodenstein** and **M. Katayama**. (Zeitschr. Elektrochem. 15. pp. 244–249, April 15, 1909.)—The authors have made use of the Ladenburg-Lehmann manometer (a simple silica aneroid) to study the variations of pressure in gases which would attack the mercury surface of an ordinary manometer; the instrument can be used for direct readings up to 600°, and if filled with the gas to be investigated and jacketed with air under variable measured pressure, can be used as a zero-instrument up to 700°. The cases investigated were $H_2SO_4 \rightleftarrows H_2O + SO_3$ from 320° to 500° in acids of 94, 85, and 100·5 per cent. strength, and $2NO_2 \rightleftarrows 2NO + O_2$ up to 700°. The results obtained were in close agreement with the numbers calculated from Nernst's equation for the dissociation of gases at variable temperatures and pressures.

T. M. L.

1811. *Absorption by, and Mobility of Ions of Neodymium.* **A. Campetti.** (Accad. Lincei, Atti, 18. pp. 53–58, July 18, 1909.)—Measurements of the conductivities and transport-numbers of solutions of neodymium chloride give the mobility of the kathion as between 56 and 60, which is much lower than the values found by Roux [Abstract No. 512 (1908)] for other trivalent ions from rare earths, viz., La, Yt, Ce, and Gd. It is considered probable that in solutions of neodymium chloride and sulphate only a small proportion of the ions are, at any one moment, absolutely free, the greater number being attached to molecules of the solvent, so that the mean mobility, as determined by the transport-numbers and conductivity, does not bear any relation to the absorption produced by the solutions. W. H. Si.

1812. *Electromotive Force of Zinc Amalgams.* **E. Cohen** and **W. Tombrock.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 98–104, Aug. 31, 1909.)—An account of some measurements of the e.m.f. of cells of the type—

Zinc amalgam 10 per cent.	Dilute solution of Zinc sulphate.	Zinc amalgam *x* per cent.

the 10 per cent. amalgam being introduced into all of the cells owing to the instability of the potential of a zinc rod. When *x* had the following values, 0·108, 0·309, 0·619, 1·031, 1·134, and 1·237, the recorded e.m.f.'s were 0·0285, 0·0161, 0·0078, 0·0024, 0·0016 and 0·0007 volt respectively. For higher concentrations, up to 38·8 per cent. of zinc the e.m.f.'s were very small and somewhat uncertain, but with a 60 per cent. amalgam a difference of 0·0009 volt was obtained. It is concluded that in cases where a p.d. exists between zinc and zinc amalgam, the zinc forms the negative pole. F. E. S.

1813. *Ionisation Relations of Ortho- and Pyro-phosphoric Acids and their Sodium Salts.* **G. A. Abbott** and **W. C. Bray.** (Amer. Chem. Soc., Journ. 31. pp. 729–768, July, 1909. Contribution from the Lab. of Phys. Chem., Mass. Inst. of Technology.)—Methods are described for preparing and analysing pure solutions of ortho- and pyro-phosphoric acids and their sodium and ammonium salts, and measurements are recorded of the conductivity of the acids and their sodium salts. The hydrolysis of the ammonium salts was determined by shaking the solutions with chloroform and determining the concentration of the ammonia in this solvent and its ratio of distribution between pure chloroform and pure water. Assuming the salts to be completely ionised, it was possible to deduce from these observations preliminary values for the ionisation constants for each successive hydrogen atom of the acids; the preliminary values were then corrected for incomplete ionisation of the salts, and the figures shown in the following table were deduced, those for other typical acids being included for purposes of comparison :—

IONISATION CONSTANTS AT 18°.

Orthophosphoric................	H_2PO_4-	$+ H+$	$1{\cdot}1 \times 10^{-2}$
Orthophosphoric................	HPO_4--	$+ H+$	$1{\cdot}95 \times 10^{-7}$
Orthophosphoric................	PO_4---	$+ H+$	$3{\cdot}6 \times 10^{-13}$
Pyrophosphoric	$H_3P_2O_7-$	$+ H+$	$1{\cdot}4 \times 10^{-1}$
Pyrophosphoric	$H_2P_2O_7--$	$+ H+$	$1{\cdot}1 \times 10^{-2}$
Pyrophosphoric	HP_2O_7---	$+ H+$	$2{\cdot}9 \times 10^{-7}$
Pyrophosphoric	P_2O_7----	$+ H+$	$3{\cdot}6 \times 10^{-9}$
Hydrochloric	$Cl-$	$+ H+$	6×10^{-1}
Hydrosulphate ion............	SO_4--	$+ H+$	$1{\cdot}9 \times 10^{-2}$
Acetic	$C_2H_3O_2-$	$+ H+$	$1{\cdot}8 \times 10^{-5}$
Carbonic	HCO_3-	$+ H+$	$3{\cdot}0 \times 10^{-7}$
Hydrocarbonic ion	CO_3--	$+ H+$	$6{\cdot}0 \times 10^{-11}$
Hydrosulphic	$HS-$	$+ H+$	$9{\cdot}1 \times 10^{-8}$
Hydrosulphide ion............	$S--$	$+ H+$	$1{\cdot}2 \times 10^{-15}$
Boric..............................	H_2BO_3-	$+ H+$	$1{\cdot}7 \times 10^{-9}$

It will be seen that orthophosphoric acid acts as a strong acid as regards the first equivalent of hydrogen, as a weak acid intermediate between carbonic acid and hydrogen sulphide as regards the second equivalent, whilst the third equivalent of hydrogen is only equal in acidity to the second equivalent in these two feeble acids. Pyrophosphoric acid is not quite so strong as hydrochloric or nitric acid as regards its first equivalent of hydrogen; its second and third equivalents resemble closely the first and second equivalents in the ortho-acid; the fourth equivalent is much weaker, but far less feebly acidic than the third equivalent of the ortho-acid. T. M. L

1814. *Thermodynamics of Weston Standard Cell.* **G. A. Hulett.** (Amer. Electrochem. Soc., Trans. 15. pp. 435–438; Discussion, p. 439, 1909.)—Using the Gibbs-Helmholtz equation, Cohen has calculated the effective heat of the reactions in the Weston cell as 46,880 cals., while from considerations of the separate processes in the cell the value 47,286 cals. was obtained. One of these processes assumes that the cadmium sulphate formed inside the cell is formed from the cadmium of a 2-phase amalgam. Cohen used a 14·3 per cent. amalgam at 18° C., and since it is believed that this does not form a 2-phase system below 25° C. it is probable that both the e.m.f. and temperature-coefficient observed by Cohen were too low. Moreover, the composition of

the 2-phase electrode changes with the temperature, and the question as to whether the Gibbs-Helmholtz equation contemplates such a change in arriving at the temperature-coefficient of a cell, is to be considered.
F. E. S.

1815. *Lead Peroxide Anodes.* (D.R.-P. 206,329. Zeitschr. Elektrochem. 15. p. 554, Aug. 1, 1909. Abstract.)—P. Ferchland finds that the PbO_2 resulting from the electrolysis of soluble lead salts, *e.g.*, nitrate, has sufficient strength and conductivity to be useful for anodes. The conductivity is about 1/100 of that of copper, and tubes 18 mm. diam., 600 mm. long, and of 6 mm. thickness of wall can be made, which will carry 6,000 amps. per $dm.^2$ of cross-section. The anodes can be made as stated in D.R.-P. 140,317. F. R.

1816. *Function of Addition-agents in Electrolytes.* **E. F. Kern.** (Amer. Electrochem. Soc., Trans. 15. pp. 441–474; Discussion, pp. 475–476, 1909.)—One of the means which is practised in order to produce smooth, solid, coherent electrodeposits is to add to the electrolyte certain reagents (addition-agents), which cause the deposit to become more dense and less crystalline. The author has submitted the matter to a detailed investigation. The metals deposited were Cu, Pb, Ag, Ni, and Fe, and the electrolytes used were: cupric sulphate, cuprous chloride and cupric fluosilicate, lead nitrate and lead fluosilicate, silver nitrate and silver fluosilicate, nickel sulphate, nickel chloride, nickel fluosilicate and nickel fluoborate, ferrous sulphate and ferrous chloride. The addition agents tried were gelatine, resorcinol, pyrogallol, and tannin. Experiments were made at different temperatures, with different current-densities, and with varying concentrations of the electrolytes and addition-agents. The results are very numerous, and may be summarised as follows: The deposits of Pb, Cu, and Ag tend to be more crystalline and less coherent with higher current densities. The smoother deposits form with lower current-densities. With rise in temperature of the electrolytes of lead, copper, and silver up to 60° C., the tendency of the deposit is to become more coherent, denser, and less crystalline. The fluosilicate electrolytes of lead, copper, and silver give more coherent deposits than those formed in the nitrate electrolytes of lead or silver, or in the sulphate or chloride electrolytes of copper. *Lead.*—The crystallisation of the deposits of lead, formed in an almost neutral electrolyte of lead nitrate, is restrained by having present one part of either tannin, resorcinol, pyrogallol or gelatine per 250 parts of electrolyte. The deposits, however, were in all cases composed of a mass of non-coherent crystals. Tannin is the most satisfactory addition agent for a lead nitrate electrolyte. Gelatine, tannin, and pyrogallol, when present in a lead fluosilicate electrolyte in the proportion of one part by weight to 5,000 parts electrolyte causes the lead to deposit as a smooth, dense, coherent mass. The most effective of these addition-agents is gelatine, the next is tannin, and the least effective is pyrogallol. *Copper.*—The deposits of copper from copper sulphate electrolytes are rendered smoother and brighter by the presence in the electrolyte of either tannin, pyrogallol, or gelatine. Tannin is the most effective of the three. The deposits of copper from cuprous chloride electrolytes are not improved by the presence in the electrolyte of either gelatine, pyrogallol, or dextrine. A higher temperature does not cause the Cu to deposit more coherently from this electrolyte. *Silver.*—Silver is deposited as finer crystals and in a more coherent form from electrolytes of silver nitrate and silver fluosilicate, when the electrolytes are at a temperature

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of 40° C., than when at a temperature of either 20° or 60° C. Deposits of Ag from a silver fluosilicate electrolyte are more coherent than deposits formed from a silver nitrate electrolyte. Gelatine, when present in silver nitrate and silver fluosilicate electrolytes in the proportion of one part per 10,000 to 14,000 parts electrolyte, causes the deposit to form as shorter and smaller crystals, which are more coherent than when gelatine is not present. Pyrogallol, tannin, and resorcinol are not suitable addition-agents for silver nitrate or fluosilicate electrolytes. *Nickel.*—The presence of free acid in nickel chloride, nickel sulphate, and nickel fluosilicate electrolytes caused very low kathode efficiency, whereas the anode efficiency was in most cases over 90 per cent. By continued electrolysis the free acid was neutralised and the kathode efficiency increased. The electrolysis of neutral nickel chloride and nickel fluosilicate solutions with current densities of 10 and 20 amps. per sq. ft. gave very satisfactory deposits, and high-current efficiencies. Neutral nickel sulphate solutions were unsatisfactory, as precipitates of insoluble basic salts formed and mixed with the deposited metal. Heating the nickel chloride and nickel fluosilicate electrolytes decreased the e.m.f., increased the current efficiencies, and improved the deposition. The most satisfactory temperature was about 40° C. During electrolysis of nickel fluosilicate solutions a small amount of gelatinous silica separated, and collected on the bottom of the cells. Heating these solutions above 75° C. also caused the separation of silica, but very slowly. A small amount of basic salts separated from the neutral nickel chloride electrolytes during electrolysis, but did not interfere with the deposition. The presence of a small amount of free acid prevented their formation. The presence of the sodium salt in the nickel chloride electrolytes was not very beneficial, whereas its presence in the neutral sulphate electrolytes reduced the e.m.f. over 60 per cent., caused the formation of good deposits and also increased the current efficiency to approximately 100 per cent. when the temperature was about 60° C. At room temperature the presence of the sodium salt in the sulphate electrolyte was of no great benefit. Satisfactory deposits of Ni were obtained from neutral solutions of nickel fluoborate electrolytes when the electrolysis was conducted at room temperature, and using a current density of 10–15 amps. per sq. ft. At temperatures above 35° C. the solution was decomposed, causing the precipitation of an insoluble basic salt. *Iron.*—Good deposits of iron were obtained by the electrolysis of neutral electrolytes containing either 8 per cent. of iron as $FeSO_4$, or 6 per cent. Fe and 3 per cent. Na as sulphates, or 8 per cent. Fe and 4–7 per cent. Na as chlorides. The presence of the larger amount of NaCl in the electrolytes prevented the vertical ridging of the deposit, and made it smoother. The finer-grained deposits of iron from the sulphate electrolytes were formed in the solutions which contained the sodium salt. The deposits of Fe formed in neutral chloride electrolytes containing sodium chloride were finer-grained and more flexible than those formed in neutral sulphate electrolytes. The deposits of Fe formed smoother when the electrolysis was conducted at 40–60° C. than when conducted at room temperature. The general statement may be made: That the most suitable organic addition-agents for lead, copper and silver electrolytes are compounds of the benzene ring series which have a large number of adjacent hydroxyl radicals. The greater the molecular weight of the addition-agent and the larger the number of adjacent hydroxyl (and amine) radicals which the compound contains, the more effective is it in producing denser, brighter, less crystalline and more adherent deposits of Cu, Pb, and Ag. The function of the addition-agent is probably to maintain a

reducing menstruum around the kathode, this causing the electro-deposit to form denser and smoother. In order to increase the density, the smoothness and the coherency of electro-deposits, the necessary conditions are: (1) For metals which stand higher than hydrogen in the potential series, neutral, or alkaline electrolytes. (2) Pure electrolytes that are free from salts of metals which stand in the potential series close to, or below the metal being deposited. (3) Electrolytes containing anions which are not highly oxidising. (4) A current density which is not greater than that necessary to deposit the metal as rapidly as the kathions are supplied to the layer of electrolyte surrounding the kathode. (5) Ample circulation to keep the layer of electrolyte surrounding the kathode sufficiently supplied with kathions. (6) Concentrated electrolytes, and consequently the more soluble salts should be used. (7) Electrolytes free from suspended matter and kept at a temperature between 40° and 60° C. (8) Presence of the required amount of a suitable addition-agent, either organic, or else inorganic (such as the alkali or alkaline earth salts).
T. S. P.

1817. *Application of Graded Potentials to Ore Analysis.* **D. F. Calhane** and **J. C. Woodbury.** (Amer. Chem. Soc., Journ. 31. pp. 1048–1051, Sept., 1909.)—Details are given of the analysis of an ore containing about 1 per cent. Ag, 1 per cent. Cu, and 52 per cent. Pb. There were also small amounts of Fe, Mg, Al, and Ca. The ore was a carbonate. The apparatus used was such as is found in any ordinarily equipped laboratory, and the electrodes were stationary. The method of graded potential was used for separating the Ag and the Cu. It was necessary to carry out a number of preliminary experiments in order to find the right conditions, and since these will be different for an ore of different composition it is unnecessary to refer to them. An interesting fact in connection with the silver was noticed. Nitric acid solutions were used for the electrolysis, but probably owing to the small percentage of silver no silver peroxide was formed on the anode.
T. S. P.

1818. *Electrolytic Deposition of Lead and Zinc as affected by the Addition of certain Organic Compounds.* **S. A. Tucker** and **E. G. Thomssen.** (Amer. Electrochem. Soc., Trans. 15. pp. 477–482; Discussion, p. 483, 1909.)—Both lead and zinc present certain difficulties when deposited electrolytically from aqueous solution, and with the former it is practically impossible to deposit the metal in a reguline condition from solutions of the nitrate or acetate. The present investigation gives an account of the study of the deposits of these metals from electrolytes to which liquorice root or extract has been added, as recommended by Classen. The points investigated were: the influence of the organic matter on the ratio of the metal actually deposited and that theoretically possible; the effect of changes in the voltage and current density, and certain changes which occurred in the electrolyte. Anodes of the metal to be deposited were used, the kathodes being of smooth copper, anode and kathode having an area of 50 sq. cm. each. The experiments showed that with both lead and zinc the deposit actually obtained exceeded that of theory in nearly every case, the liquorice root giving higher results than the extract. Better deposits were obtained with the extract than with the root. In every case the deposits were very good, adhering firmly if the kathode was perfectly clean at the start, and if the current density was not too high. The zinc deposited bright, but the lead was unpolished. The best results were obtained with a current density of about

0·5 amp. per dm.^{2}; with 2 amps. per dm.^{2} the deposits became dark, rough, and non-adherent. Analysis of the deposit showed that organic matter was carried over with the metal deposited, the amount in a fresh bath being generally less than two-tenths of 1 per cent. As the bath grows older more is found. In obtaining thick deposits of lead or zinc it was found that the deposit at the end of several hours became very poor. This was due to the bath itself, since if more of the liquorice was added when poor deposits were being obtained the bath became as good as when fresh. Stirring the electrolyte enabled higher current-densities to be used, but deterioration of the bath took place after prolonged working. In the *discussion*, **Rodman** pointed out that electrolytic lead cannot be used in storage battery construction, as it is very liable to chemical and electrochemical attack.

T. S. P.

1819. *Determination of Thallium in the Electrolytic Way.* **G. W. Morden.** (Amer. Chem. Soc., Journ. 31. pp. 1045–1048, Sept., 1909. Contribution from the John Harrison Lab. of Chemistry.)—The electrolytic estimation of thallium is rendered difficult by the ease with which the deposited metal oxidises. Two methods have been devised by means of which this oxidation may be prevented. In the first method the Tl, after being deposited, is covered by a protective coating of non-oxidisable metal. Neither Ag nor Cu, nor even Ni can be used, since they are higher than Tl in the potential series, but Zn was found to give satisfactory results. In the determination the thallium was first deposited from a cyanide electrolyte, using a dish kathode and rotating anode, the current density employed being 1 amp. per dm.^{2} at a potential of 3–4 volts. When the solution gave no test for Tl the electrolyte was syphoned off with the simultaneous introduction of pure water into the dish, until the zero reading of the ammeter indicated that all the original solution had been removed. A definite volume of zinc sulphate solution of known strength was then added, together with sodium acetate, and the zinc deposited on the Tl. Thallium could also be deposited from an acetic acid solution with the addition of sodium acetate. The zinc solution could then be added without previously syphoning off the first liquid. In these ways it was possible to deposit 0·1 gm. of Tl and 0·17 gm. of Zn in from 20–45 min. The results agree very well among themselves, but there is no indication as to the exact amount of Tl taken in each experiment. In the second method an attempt was made to use a mercury kathode, but it was impossible to wash the amalgam without oxidation taking place. However, it was found that if an amalgam of zinc was used as kathode instead of pure mercury the Zn-Tl amalgam formed after deposition of the Tl could be treated in the usual way without oxidation taking place. 0·2 gm. Tl could be deposited in 10 min. Only very small quantities of zinc were necessary to prevent the oxidation of the Tl in the Zn-Tl amalgam.

T. S. P.

1820. *Rapid Electrochemical Analysis. A Comparison of Several Methods.* **L. S. Palmer** and **R. C. Palmer.** (Amer. Electrochem. Soc., Trans. 15. pp. 489–493; Discussion, pp. 494–496, 1909.)—Some experiments on the determination of copper with Frary's apparatus led the authors to believe that the speed with which complete deposition was obtained was not wholly accounted for by the fact that the electrolyte rotated, but depended to a large extent upon the nature of the electrodes. To test this supposition a series of tests have been carried out to determine the relative merits of the two factors, gauze kathode and rotating electrolyte, in rapid depositions. Three sets of tests were made with cupric sulphate solutions—one with a rotating electrolyte using the gauze kathode, a second set without rotation of electrolyte using a gauze kathode, and for comparison a series using the usual form of Pt cone as kathode, without rotation of the electrolyte. Two sets of tests were made on zinc depositions similar to the first two for copper, with the exception that the electrolyte was cooled by means of water flowing through a lead spiral surrounding the vessel containing it, as described by Frary. It was found that 0·31 gm. of Cu was completely deposited on the gauze kathode in 25 min. with magnetic rotation of the electrolyte, in 50 min. without rotation, and in 5 hours using the Pt cone electrode. It thus seems that the rapidity of Frary's method is due, in a large measure, to the gauze kathode. In the case of zinc, there was no difference in time required for complete deposition in the two experiments, the reason given being that the lead coil reduced the rotation of the electrolyte to such a large extent that the slight rotation that might still exist had very little effect on the rate of deposition. The authors conclude that the use of a gauze kathode plays a sufficiently important part to warrant its use alone for simple rapid determinations, thus dispensing with the various mechanical devices for agitation of the electrolyte. In the *discussion*, **Frary** considers that the authors' conclusion is premature.

T. S. P.

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1821. *On the Theory of Anisotropic Liquids.* **E. Bose.** (Phys. Zeitschr. 9. pp. 708–713, Oct. 15, 1908, and 10. pp. 230–244, April 1, 1909.)—A theoretical discussion of the conditions in "liquid crystals."

1822. *Sodium Sulphite and its Equilibrium with Water.* **H. Hartley** and **W. H. Barrett.** (Chem. Soc., Journ. 95. pp. 1178–1185, June, 1909.)

1823. *Action of the Continuous Current on Symmetrical Chains of Aqueous Solutions of Electrolytes not having Common Ions.* **M. Chanoz.** (Comptes Rendus, 148. pp. 986–988, April 13, 1909.)—The author finds that with unsymmetrical chains the phenomena are more complicated than with symmetrical; he explains the observed results by assuming the chemical interaction of the kathions moving in one direction with the anions moving in the other. D. H. J.

1824. *Dissociation-Equilibria in Aqueous Potassium Mercuri-iodide Solutions.* **H. M. Dawson.** (Chem. Soc., Journ. 95. pp. 870–878, May, 1909.)

1825. *Equilibrium in the System: Silver Chloride and Pyridine.* **L. Kahlenberg** and **W. J. Wittich.** (Journ. Phys. Chem. 13. pp. 421–425, June, 1909.)

1826. *Calculation of Specific Heats of Solutions.* **A. Bakowski.** (Zeitschr. Phys. Chem. 65. 6. pp. 727–736, March 16, 1909. Physikal. Inst., Bonn.)—An equation, based upon a knowledge of molecular conductivities, is deduced for the specific heat of an aqueous solution. It is claimed that it gives the same agreement with experimental values as an equation deduced empirically by Mathias. Deviations are ascribed to the formation of hydrates. T. M. L.

1827. *Velocity of Absorption and Liberation of Carbon Dioxide by Water.* **J. Meyer.** (Zeitschr. Elektrochem. 15. pp. 249–252, April 15, 1909.)—A review of recent work on heterogeneous systems, dealing especially with the experimental work of Knox on the displacement of CO_2 by air from a saturated aqueous solution, and the somewhat similar work of C. Bohr. T. M. L.